Bacteriological Characteristics of Twenty Recreational Beaches Manitoba, Canada 1984

Water Standards and Studies Report #85-3

Manitoba
Environment and
Workplace Safety
and Health

BACTERIOLOGICAL CHARACTERISTICS OF TWENTY RECREATIONAL BEACHES, MANITOBA, CANADA, 1984.

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SUMMARY

Surface waters may become contaminated with harmful, microbiological organisms of fecal origin as a result of some of man's activities. The presence of excessive numbers of these organisms may impair such waters for some recreational uses.

Water-borne diseases associated with bathing in surface waters are most often expressed as infections of the gastrointestinal tract as well as infections of the eyes, ears, nose and throat. Symptoms of gastrointestinal infections include mild fever, vomiting, diarrhea and stomach cramps. These symptoms typically do not last for more than several days and medical attention is usually not required.

The quality of recreational water has usually been assessed by measuring the densities of groups of "indicator" bacteria. This is necessary because of the technical difficulties associated with analyzing water for many of the specific pathogens responsible for the various infections. Thus, when large numbers of indicator bacteria are observed, there is a significant possibility that disease causing organisms may also be present.

In very recent years, scientists have been able to link increases in the number of cases of gastroenteritis amongst bathers with increases in the densities of certain bacterial indicator groups. This link, however, is more tenuous for associating infections of the eyes, ears, nose and throat with changes in the densities of bacterial indicator groups.

Recreational water quality objectives for the fecal coliform group of indicator bacteria have existed within Manitoba for a number of years, and more recently, similar guidelines have been recommended by a joint provincial-federal working group. The findings of this group were published in 1983 within the document "Guidelines for Canadian Recreational Water Quality". The objective recommended for the indicator group fecal coliform was 200 organisms/100 mL and was expressed as a maximum 30-day geometric mean limit of a specified minimum number of samples. This recommended objective was thought to represent a maximum risk of 1.5% of contracting gastrointestinal infections while bathing. This risk could alternately be stated such that 15 persons out of every 1000 bathers could be expected to contract gastroenteritis while bathing in water containing the maximum fecal coliform limit. However, recently acquired scientific information applicable to Manitoba's fresh water, indicated that the risk of contracting gastroenteritis while bathing in water containing the maximum fecal coliform limit is probably 0.82% rather than 1.5% (or 8.2 rather than 15 expected cases of gastroenteritis per 1000 bathers).

Further, subsequent authoritative investigations have shown that the enterococcus indicator group is superior for assessing recreational water quality than the fecal coliform indicator group. Unfortunately, a recreational water quality objective for this indicator group, suitable for application within Manitoba, had not previously been developed. An appropriate objective for enterococci densities was therefore developed, for the purpose of interpreting data from this investigation. This resultant objective for enterococci was 50 organisms/100 mL. This objective is comparable to the existing objective for fecal coliforms. That is, both are expressed as a maximum 30-day geometric mean limit and both represent an estimated risk of 0.82% of contracting gastrointestinal infections while bathing in water containing the maximum limit.

Other fecal coliform and enterococcus objectives were also utilized in order to limit the magnitude of the indicator organism densities within single samples. Exceedences of these objectives, termed the individual maximum, signal the existence of potential problems that required further investigations. The individual maximum objectives for fecal coliform and enterococcus were 400 organisms/100 mL and 100 organisms/100 mL, respectively.

The microbiological quality of twenty beaches was assessed during the summer of 1984, using observed population densities of the indicator organisms fecal coliform and enterococcus in relation to these recreational water quality objectives. The beaches were located on the east and west sides of Lake Winnipeg and within the Whiteshell Provincial Park.

The beaches located on lakes within the Whiteshell Provincial Park (Falcon (Main Beach and Faloma Beach), Star, West Hawk, Caddy, Betula, Nutimik and Dorothy) displayed excellent bacterial quality in relation to the recreational water quality objectives.

The beaches located on the east side of Lake Winnipeg (Victoria (Club House Beach and Ski Dock Area), Hillside, Lester, Grand (East Beach and West Beach), and Patricia) displayed good bacterial quality in relation to the recreational water quality objectives. Occasionally, slightly elevated values were observed in one or more of the samples collected on isolated sampling periods. However, the measured fecal coliform organism densities were within the maximum 30-day geometric mean limit. The enterococcus organism objective, developed during this investigation, was exceeded marginally on one occasion at one beach (Victoria (Ski Dock Area)).

The beaches located on the west side of Lake Winnipeg (Gimli, Sandy Hook, Winnipeg, Matlock and Sans Souci) were somewhat reduced in microbiological quality when compared to the recreational water

quality objectives. A number of individual samples contained elevated densities of both fecal coliform and enterococcus organisms. The fecal coliform 30-day geometric mean objective however, was only marginally exceeded at one beach (Matlock) on one occasion.

The use of the recreational water quality objective for enterococcus organisms, developed for this investigation, produced apparently conflicting results. The developed enterococcus maximum 30-day geometric mean limit was exceeded for a large portion of the study period at all west side Lake Winnipeg beaches. These exceedences resulted in an estimated additional risk of contracting gastroenteritis while bathing at these beaches ranging from 0.12% to 0.32%. This corresponded to an estimated occurrence of 9.4 to 11.4 persons contracting gastrointestinal infections amongst every 1000 west side Lake Winnipeg bathers. The small magnitude of this additional risk should not have significantly impaired the recreational quality of these beaches.

Subjective estimates were made at the times of sample collections of numerous environmental factors including turbidity, wind direction, wave action as well as other related variables such as bather load. However, the observed variations in the densities of the two indicator organism groups were not correlated with these factors at any of the study beaches.

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ABSTRACT

The water quality of twenty beaches was examined during the summer of 1984 using observed fecal coliform and enterococcus indicator organism group densities in comparison to respective recreational water quality objectives. The recreational water quality objectives for fecal coliform organisms were adopted from recommendations contained in the document entitled "Guidelines for Canadian Recreational Water Quality", published in 1983, and from water quality objectives presently existing within Manitoba. The recreational water quality objectives for enterococcus organisms were developed from the results of published epidemiological studies conducted on other North American freshwater bathing areas. The respective objectives for these indicator groups are 200 fecal coliform organisms/100 mL and 50 enterococcus organisms/100 mL. These objectives are comparable since both are expressed as maximum 30-day geometric mean limits based upon a minimum number of samples and both represent an estimated risk of 0.82% of contracting gastrointestinal infections while bathing in water containing the maximum limits (or 8.2 expected cases of gastrointestinal infections/1000 bathers). Other fecal coliform and enterococcus objectives were utilized in order to limit the magnitude of bacterial densities in single samples.

The beaches assessed were located on the east and west sides of Lake Winnipeg and within the Whiteshell Provincial Park. All beaches excepting those located on the west side of Lake Winnipeg displayed good microbiological quality characteristics in comparison to the recreational water quality objectives.

The microbiological quality of the beaches located on the west side of Lake Winnipeg was somewhat reduced in comparison to the recreational water quality objectives. The two indicator groups used for this assessment however, produced apparently conflicting results. The fecal coliform maximum 30-day geometric mean limit was only marginally exceeded at one beach (Matlock) on one occasion. However, the enterococcus maximum 30-day geometric mean limit was regularly exceeded at all west side Lake Winnipeg beaches. These exceedences resulted in an estimated maximum increased risk of 0.32% of contracting gastrointestinal illnesses while bathing (or an estimated

maximum 11.4 cases of gastrointestinal illnesses per 1000 west side Lake Winnipeg bathers). The small magnitude of this additional risk should not have significantly impaired the recreational quality of these beaches.

Variations in the population densities of the indicator organisms were not found to be related to numerous environmental factors including temperature, wind direction, precipitation events, wave action, turbidity, bather load plus others.

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1. INTRODUCTION

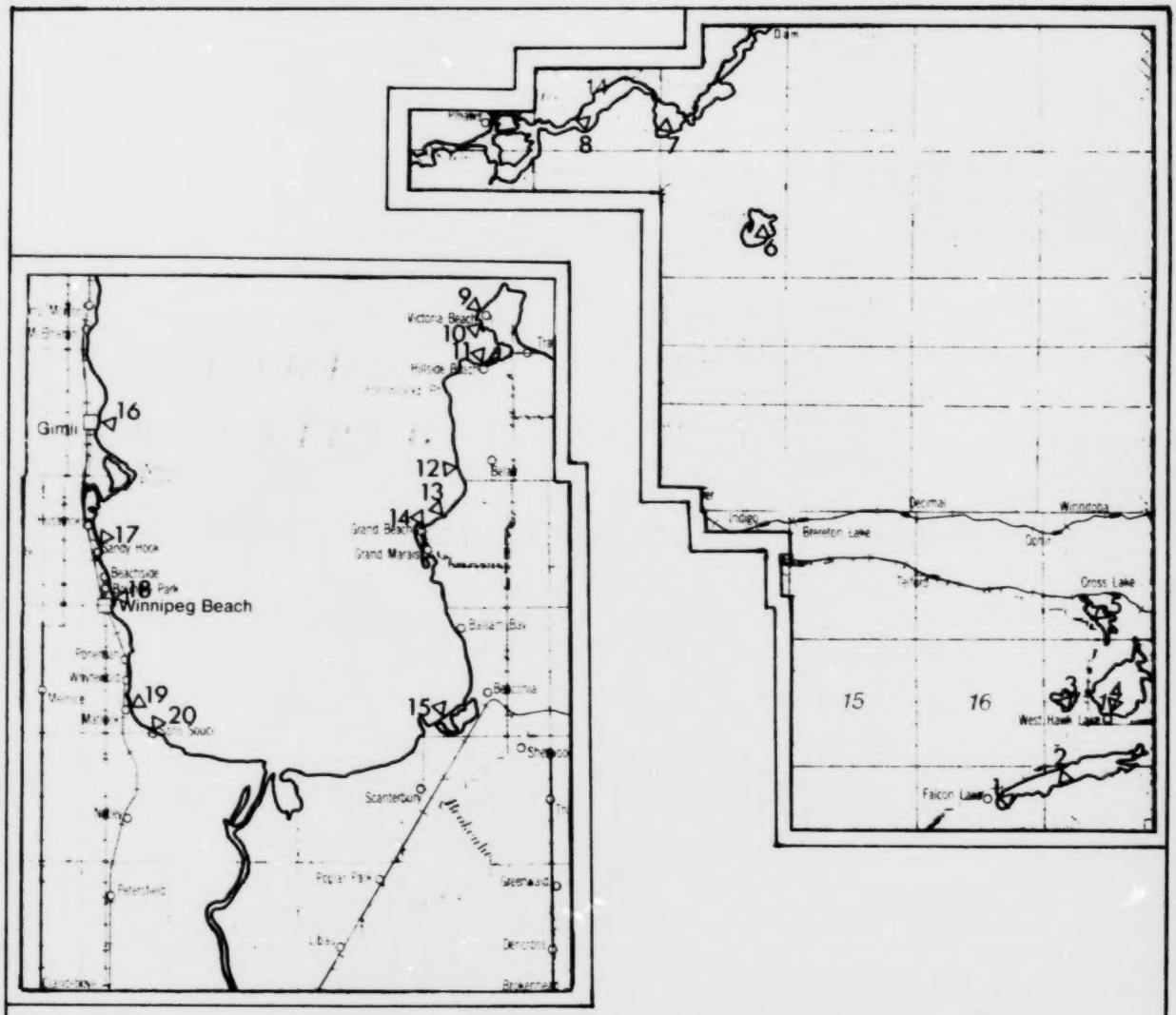
Manitoba's abundant lakes and rivers offer excellent water-related recreational opportunities. Many water bodies are accessible within a reasonable driving distance from large populated centres; hence they are extensively utilized. Because of the ever present possibility of microbiological contamination of recreational waters, assessments should periodically be conducted in order to determine whether or not bathers are being exposed to unacceptable health risks. The most common ailments associated with impaired recreational water quality are gastrointestinal illnesses as well as infections of the upper respiratory tract, including the eyes and ears.

Twenty beaches were originally selected for assessment during 1984. The locations are shown in Figure 1. All beaches were located either on Lake Winnipeg or within the Whiteshell Provincial Park.

1.1 Surface Water Quality Objectives Related to Primary Recreation (Bathing)

Extensive research has been conducted in order to determine suitable microbiological indicator organisms that firstly, can be practically measured and that secondly, can be unequivocally linked to predictable changes in the incidence of aquatic recreation related infections (Cabelli, 1976, 1978, 1979; Dufour, 1984; Dutka, 1979; Fuhs, 1975; Palmer et al, 1984).

The relationship between indicator organism concentrations and bather-related infections is complicated by many variables. These include the often changing ratios between indicator organism densities



LEGEND

1. Falcon Beach (Main)
2. Faloma Beach
3. Star Beach
4. West Hawk Beach
5. Caddy Beach
6. Betula Beach
7. Nutimik Beach
8. Dorothy Beach
9. Victoria Beach (Club House area)
10. Victoria Beach (Ski dock area)
11. Hillside Beach
12. Lester Beach
13. Grand Beach (East)
14. Grand Beach (West)
15. Patricia Beach
16. Gimli Beach
17. Sandy Hook Beach
18. Winnipeg Beach
19. Matlock Beach
20. Sans Souci Beach

Figure 1: Map showing the locations of beaches monitored during the bathing season, 1984.

and specific pathogens, the numbers of infected individuals in any given population contributing towards the contamination of a receiving waterbody, the infectious dose required to cause an illness and the immune system or defense mechanisms developed by individual bathers to combat specific pathogens. Regarding this latter uncertainty, it is noted that Cabelli (1979) has reported that children under the age of 10 years comprise one of the groups most susceptible to bather-related disease incidence. Cabelli (1979) attributed this in part, to their poorly developed immune system with respect to water-borne infectious agents.

The most prevalent gastrointestinal illnesses associated with recreational water are expressed through relatively benign symptoms such as fever, vomiting, diarrhea and stomach cramps (Cabelli, 1979). The duration typically is relatively short and most patients do not require medical attention (Cabelli, 1979).

Water quality managers have historically predicated recreational water quality objectives on intuitive relationships between indicator organism densities, pathogenic organism presence and the incidence of disease outbreaks amongst bathers. However, in recent years this relationship has been established empirically through rigorous epidemiological studies. Cabelli (1979) established such a relationship between the indicator organism Escherichia coli and the enterococci group with the incidence of gastrointestinal illness rates of bathers in marine waters. Dufour (1984) established a mathematical relationship between indicator organism densities and

illness rates amongst bathers in fresh water. Dufour (1984) further reported that the relationship for fresh water was different than that reported by Cabelli (1979) for marine waters. Both Cabelli (1979) and Dufour (1984) however confirmed that gastrointestinal illness rates in bathers were correlated best with enterococci group densities. *E. coli* densities were also strongly correlated with such disease occurrences. However, fecal coliform group densities were not well correlated. These findings are important with regard to interpreting data generated from the present investigation.

Health and Welfare Canada (1983) recommended a maximum fecal coliform 30-day geometric mean limit of 200 organisms/100 mL as a guideline for the protection of Canadian recreational water quality. Health and Welfare Canada (1983) further recommended that investigations should be undertaken when individual maximum values exceeded 400 organisms/100 mL or two times the 30-day geometric mean guideline. Williamson (1983) proposed adoption of these guidelines for application in Manitoba for the protection of primary recreation. However, these recommendations were based, in part, on Cabelli's (1979) correlation between *E. coli* densities and bather illness rates in marine waters. This correlation ($y = 0.818 \log x - 0.374$) resulted in an estimated risk of contracting gastrointestinal infections of 1.5% following bathing in marine water containing the recommended fecal coliform guideline densities. Extrapolation to fresh waters, using Dufour's (1984) correlation ($y = 0.4235 \log x - 0.1505$) resulted in an estimated risk of contracting gastrointestinal infections of

0.82% following bathing in water containing E. coli densities of 200 organisms/100 mL (30-day geometric mean).

Both Cabelli (1979) and Dufour (1984) reported correlations with E. coli and illness rates. However, the primary recreation objective is expressed in terms of densities of the indicator group fecal coliform. This may add a minimal safety factor since, while E. coli is measured in the fecal coliform test, it may not always comprise 100% of the organisms quantified in all analyses from all locations.

Both Cabelli (1979) and Dufour (1984), as previously discussed, reported good correlations between the enterococci group and bather related gastrointestinal illnesses in marine and fresh water, respectively. However, neither Health and Welfare Canada (1983) nor Williamson (1983) recommended an enterococci group density objective suitable for protecting surface waters for bathing purposes. Such an objective can be easily computed using Dufour's (1984) enterococci relationship ($y = 0.6138 \log x - 0.2132$) with illness rates in bathers. For the purpose of this investigation, it appeared congruent to use the risk of 0.82% estimated by Dufour (1984) of contracting gastrointestinal illness while bathing in fresh water containing the maximum fecal coliform 30-day geometric mean limit of 200 organisms/100 mL. Thus, bathing in fresh water containing a 30-day geometric mean enterococci density of approximately 50 organisms/100 mL resulted in a risk of contracting gastroenteritis equivalent to bathing in fresh water containing a 30-day geometric

mean E. coli density of 200 organisms/100 mL. A density of two times the 30-day geometric mean or 100 enterococci/100 mL provided an individual maximum objective density that would signal potential problems necessitating further investigations. This latter objective is also consistent with the accepted E. coli individual maximum.

In addition to incidences of gastrointestinal illnesses, infections of the eyes, ears, nose and throat often predominate amongst bathers. The etiological agent often identified with infections of the ear, or otitis externa in association with bathing is the bacterium Pseudomonas aeruginosa (Aquatic Ecosystem Objectives Committee, 1983). Calderon and Mood (1982) however, state that the causal link between P. aeruginosa ear infections and swimming in waters containing P. aeruginosa may be presumptive. Swimming apparently predisposes the ear canal to many microbiological infectious agents. The transmission route of these agents has not been clearly linked to bathing, except in several investigations in swimming pools.

P. aeruginosa can be contributed to surface water along with fecal material. However, because P. aeruginosa has a relatively short survival time in water, its presence is not predictable from densities of other indicator bacteria groups such as E. coli or enterococci (Hoadley, 1977). Therefore, the significance of the confirmed presence of P. aeruginosa must be interpreted solely on the basis of its own pathogenicity (Hoadley, 1977; Hoadley and Knight, 1975).

Other specific pathogens, namely Staphylococcus aureus, are responsible for purulent infections of the skin, eyes and ears. Staphylococci are often found in association with high levels of indicator bacteria, but they can also be found when indicator bacterial densities are low or absent.

In summary, a single microbiological indicator unit does not appear satisfactory for predicting the health hazards associated with the use of recreational water. Authoritative investigations have identified enterococcus and E. coli densities to be the best indicators of gastroenteritis infections amongst bathers. During the present investigation, enterococci and fecal coliforms were analyzed. Fecal coliforms were utilized as a conservative surrogate for E. coli. The objectives for these indicator organisms are as follows:

	30-day geometric mean	individual maximum
fecal coliform:	200 organisms/100 mL	400 organisms/100 mL
enterococcus:	50 organisms/100 mL	100 organisms/100 mL

The fecal coliform objective was adopted from Health and Welfare (1983) and Williamson (1983). In the absence of a similar enterococci objective, one was developed from the epidemiological investigations of Dufour (1984). Swimming in water containing either fecal coliform or enterococcus densities at the respective maximum 30-day geometric mean limit represented a risk of 0.82% of contracting gastroenteritis.

Infections of the eyes, ears, nose and throat are also common amongst bathers. The bacteria responsible for some of these infections, namely P. aeruginosa and S. aureus, can be contributed from fecal material originating from areas adjacent to recreational waters. Both P. aeruginosa and S. aureus have short survival times in surface water, therefore, their presence can not be reasonably predicted from the densities of other indicators of fecal pollution.

2. Methodology

Five samples were collected from each beach at equidistant intervals along the entire beach during each sampling occasion. The individual samples were numbered in sequence, beginning on the right-side of each beach (when facing lake-ward). Samples were collected in approximately 1.0 m of water and were collected approximately 0.1 m to 0.3 m below the surface. All samples were collected on the wind-ward side of the sampler. The pre-sterilized 125 mL glass sample containers were filled, by hand, with a slow but continuous controlled motion away from the body of the sampler. Each beach was sampled approximately eight times during each 30-day period. The sampling schedule was rotated in order that each beach could be sampled on different days of the week and at different times of the day. Consequently, each beach was sampled approximately three times on weekends during each 30-day period. Samples were chilled then delivered daily to the Cadham Provincial Laboratory for "same-day" initiation of sample analyses.

Samples collected from all locations were analyzed for fecal coliform and enterococci densities. Additional samples were collected from Victoria Beach (Ski Dock Area) (site 6) and were analyzed for *P. aeruginosa* and *S. aureus* as well as for fecal coliforms and enterococci.

Air and water temperatures and bather loads were determined at the time of sample collection. As well, subjective estimates were

made of numerous other variables such as wind direction, cloud cover, recent precipitation, visible algae, wave action, turbidity and water colour.

Fecal coliforms and enterococci were enumerated according to membrane filtration techniques outlined in Greenberg et al (eds) (1980). Pseudomonas aeruginosa was analyzed by most probable number methods detailed in Greenberg et al (eds) (1980). Staphylococcus aureus was enumerated using membrane filtration methods recommended by Taras et al (eds.) (1971) with modifications to the nutrient broth described in Greenberg et al (eds.) (1980).

With few exceptions, the lower fecal coliform densities reported from the more turbid Lake Winnipeg waters was 100 organisms/100 mL. Observed densities lower than 100 organisms/100 mL were qualified with a "<" symbol. This precluded the necessity to undertake time consuming dilutions. This was not necessary for the relatively clear waters of the study beaches located in the Whiteshell Provincial Park. Hence, fecal coliform densities could be precisely reported in the range of 1 to 100 organisms/100 mL for these waters. Also, the upper enterococci densities reported from all locations was generally 300 organisms/100 mL. Observed densities greater than 300 organisms/100 mL were qualified with a ">" designation.

3. Results and Discussion

3.1 Whiteshell Provincial Park Beaches

3.1.1 Falcon Beach (Main), Falcon Lake

Fecal coliform and enterococcus densities and related field conditions observed at Falcon Beach (Main), Falcon Lake are located in Tables 1a and 1b, respectively.

Exceedences of the fecal coliform and enterococcus objectives were not observed during the investigation.

3.1.2 Faloma Beach, Falcon Lake

Microbiological characteristics and associated field observations measured at Faloma Beach, Falcon Lake are recorded in Tables 2a and 2b, respectively.

Enumerated fecal coliform individual maximum, fecal coliform 30-day geometric mean summaries and enterococci 30-day geometric mean summaries did not exceed the recommended objectives. Two isolated individual maximum objective exceedences were observed for enterococci densities. These exceedences should not have resulted in a significantly increased health risk to swimmers. As well, these exceedences were not correlated ($P\alpha = 0.05$) with environmental variables recorded at the times of sample collections.

3.1.3 Star Beach, Star Lake

Microbiological indicator organism population densities measured at Star Beach, Star Lake are located in Table 3a. Associated environmental field conditions recorded at the times of sample collections are located in Table 3b.

Table 1a: Fecal coliform and enterococcus characteristics of Falcon Beach (main), Falcon Lake, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 17, 1984	<100	<100	<100	<100	<100	<100	<100	1	<1	<1	<1	1	<1	<1
June 2, 1984	1	1	<1	<1	<1	<1	<10	<1	5	1	1	1	<1	<1
June 7, 1984	2	10	9	8	6	6	<8	14	24	21	14	25	19	<3
June 10, 1984	6	7	15	35	12	12	<9	17	11	15	15	17	15	<4
June 15, 1984	3	21	20	25	15	14	<10	4	11	13	17	22	12	5
June 18, 1984	2	2	<1	3	3	<2	<8	<1	1	1	11	8	2	<5
June 23, 1984	<1	<1	<1	<1	<1	<1	<4	<1	<1	8	1	<1	<2	<5
June 28, 1984	2	1	<1	4	42	<3	<4	32	23	20	27	32	26	<6
July 1, 1984	<1	1	<1	<1	1	<1	<3	1	4	10	2	2	3	<6
July 6, 1984	<1	<1	<1	<1	<1	<1	<3	<1	1	1	<1	1	<1	<6
July 9, 1984	1	<1	<1	5	<1	<1	<2	3	1	7	17	3	4	<5
July 14, 1984	<1	8	3	<1	9	<3	<2	35	34	43	52	27	37	<5
July 19, 1984	27	2	<1	<1	1	<2	<2	9	2	57	2	1	5	<5
July 22, 1984	56	43	22	7	5	18	<2	80	20	23	19	49	32	<6
July 27, 1984	2	<1	<1	<1	<1	<1	<2	5	21	42	6	13	13	<8
July 30, 1984	<1	1	1	<1	2	<1	<2	6	11	6	9	5	7	<7
Aug. 4, 1984	5	<1	4	2	<1	<2	<2	10	6	7	7	8	7	<8
Aug. 9, 1984	2	2	3	3	5	3	<2	13	6	3	12	6	7	10
Aug. 12, 1984	2	12	4	38	8	8	<3	8	3	2	12	6	5	10
Aug. 17, 1984	<1	<1	<1	1	<1	<1	<3	57	61	16	25	90	42	11
Aug. 20, 1984	<1	2	4	3	2	<2	<3	12	2	5	2	1	3	10
Aug. 25, 1984	3	5	16	10	20	9	<2	<1	9	30	8	8	<7	<8
Aug. 29, 1984	1	4	<1	<1	3	<2	<3	8	3	11	3	3	5	<7
Sept. 2, 1984	<1	2	1	2	2	<2	<3	1	3	3	3	7	3	<7

Table 1b: Field observations recorded during the microbiological sample collections at Falcon Beach (main), Falcon Lake, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 17, 1984	9:00	22	10	offshore	40	light	none	none	clear	0	clear	
June 2, 1984	12:00	20	12	offshore	20	none	none	none	clear	2	clear	
June 7, 1984	10:40	17	14	onshore	45	heavy	none	none	clear	0	clear	
June 10, 1984	13:15	8	14	onshore	25	light	none	none	clear	0	clear	
June 15, 1984	8:40	16	16	offshore	90	light	none	light	clear	0	light	
June 18, 1984	11:50	18	16	offshore	90	none	none	none	clear	0	clear	
June 23, 1984	8:20	16	16	offshore	70	moderate	none	none	clear	0	clear	
June 28, 1984	11:50	22	21	offshore	0	none	none	none	clear	30	clear	
July 1, 1984	8:30	16	19	offshore	100	light	none	none	clear	0	clear	
July 6, 1984	11:40	20	20	offshore	70	none	none	none	clear	4	clear	
July 9, 1984	8:30	17	20	offshore	10	none	none	none	clear	0	clear	
July 14, 1984	-	-	-	-	-	-	-	-	-	-	-	
July 19, 1984	8:30	16	19	offshore	0	none	none	none	clear	0	clear	
July 22, 1984	11:00	24	23	offshore	60	none	none	none	clear	220	clear	
July 27, 1984	8:30	20	23	offshore	0	none	none	none	clear	0	clear	
July 30, 1984	11:40	23	24	offshore	100	light	none	none	clear	6	light	
Aug. 4, 1984	8:30	22	24	offshore	10	none	none	none	clear	0	clear	
Aug. 9, 1984	11:35	22	22	offshore	90	light	none	light	clear	14	light	
Aug. 12, 1984	8:10	17	22	offshore	10	none	none	light	clear	0	clear	
Aug. 17, 1984	11:55	22	22	onshore	10	none	light	light	clear	40	light	
Aug. 20, 1984	10:20	19	-	offshore	100	heavy	none	none	clear	0	clear	raining
Aug. 25, 1984	11:10	22	22	offshore	0	none	light	none	clear	30	light	
Aug. 29, 1984	9:50	15	19	offshore	100	none	none	none	clear	0	clear	
Sept. 2, 1984	-	-	-	-	-	-	-	-	-	-	-	

Table 2a: Fecal coliform and enterococcus characteristics of Faloma Beach, Falcon Lake, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 17, 1984	<100	<100	<100	<100	<100	<100	<100	1	9	7	2	11	4	4
June 2, 1984	<1	<1	<1	<1	<1	<1	<10	7	7	17	50	>300	>26	>11
June 7, 1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-
June 10, 1984	11	32	6	7	8	10	<10	8	7	7	10	9	8	>10
June 15, 1984	1	1	1	2	<1	<1	<6	10	10	8	12	1	6	>9
June 18, 1984	5	3	6	2	10	4	<6	10	9	10	2	10	7	>8
June 23, 1984	16	17	22	24	30	21	<4	55	36	47	39	68	48	>14
June 28, 1984	2	<1	1	<1	<1	<1	<3	28	4	1	3	2	4	>11
July 1, 1984	9	5	2	12	2	5	<3	26	13	10	5	8	11	>11
July 6, 1984	<1	<1	<1	<1	1	<1	<3	3	<1	3	4	11	<3	<8
July 9, 1984	9	10	<1	7	8	6	<4	20	12	11	16	9	13	<9
July 14, 1984	4	<1	<1	3	6	2	<3	90	92	84	71	70	81	<11
July 19, 1984	3	<1	<1	<1	<1	<1	<3	62	3	<1	<1	<1	<3	<10
July 22, 1984	8	7	15	13	1	6	<3	23	37	33	31	21	28	<12
July 27, 1984	<1	<1	1	<1	<1	<1	<2	3	2	1	1	<1	<1	<8
July 30, 1984	7	5	5	7	3	5	<3	15	13	15	22	33	18	<10
Aug. 4, 1984	4	<1	<1	3	3	<2	<2	10	5	11	27	10	11	<10
Aug. 9, 1984	3	1	1	1	2	1	<3	8	6	7	15	9	9	<11
Aug. 12, 1984	1	1	1	4	<1	<1	<2	6	13	51	72	66	29	<12
Aug. 17, 1984	<1	<1	<1	1	<1	<1	<2	>300	14	12	16	50	>33	><11
Aug. 20, 1984	1	7	1	2	2	2	<2	15	17	8	10	41	15	><13
Aug. 25, 1984	1	2	6	1	13	3	<2	27	22	44	43	68	38	><14
Aug. 29, 1984	6	9	5	9	10	8	<2	1	5	6	7	5	4	>16
Sept. 2, 1984	1	<1	<1	<1	<1	<1	<2	<1	5	3	3	24	<4	><13

Table 2b: Field observations recorded during the microbiological sample collections at Paloma Beach, Falcon Lake, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 17, 1984	9:20	22	10	onshore	40	light	none	light	clear	0	light	
June 2, 1984	11:40	20	10	onshore	20	none	none	heavy	clear	2	clear	
June 7, 1984	-	-	-	-	-	-	-	-	-	-	-	
June 10, 1984	12:55	8	14	onshore	20	light	none	none	clear	0	clear	
June 15, 1984	9:10	16	16	onshore	90	light	none	light	clear	0	clear	
June 18, 1984	11:30	18	-	onshore	90	none	none	none	clear	0	clear	
June 23, 1984	8:50	17	18	onshore	20	moderate	none	moderate	clear	0	moderate	
June 28, 1984	11:30	22	21	onshore	0	none	light	moderate	clear	2	clear	
July 1, 1984	9:00	16	20	onshore	100	light	none	none	clear	0	clear	
July 6, 1984	11:20	19	20	onshore	10	none	none	light	clear	0	light	
July 9, 1984	9:00	17	21	onshore	10	none	none	none	clear	0	clear	
July 14, 1984	11:10	22	24	onshore	0	light	light	none	clear	4	light	
July 19, 1984	8:50	17	22	onshore	0	none	light	none	clear	0	light	
July 22, 1984	10:40	24	24	onshore	60	none	moderate	none	clear	4	moderate	
July 27, 1984	9:00	20	23	offshore	0	none	none	none	clear	0	clear	
July 30, 1984	11:20	23	23	onshore	100	light	light	none	clear	6	light	
Aug. 4, 1984	8:50	23	24	onshore	10	none	light	light	clear	0	clear	
Aug. 9, 1984	11:15	22	23	onshore	90	light	light	light	clear	0	light	
Aug. 12, 1984	8:45	17	22	onshore	10	none	none	light	clear	0	clear	
Aug. 17, 1984	11:15	22	22	offshore	10	none	light	none	clear	2	light	
Aug. 20, 1984	10:50	19	-	onshore	100	heavy	none	none	clear	0	clear	
Aug. 25, 1984	10:50	22	22	onshore	0	none	light	light	clear	2	light	
Aug. 29, 1984	10:15	15	20	offshore	100	none	none	none	clear	0	clear	
Sept. 2, 1984	-	-	-	-	-	-	-	-	-	-	-	

Table 3a: Fecal coliform and enterococcus characteristics of Star Beach, Star Lake, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
June 15, 1984	<1	2	<1	1	<1	<1	<1	6	1	2	3	6	3	3
June 18, 1984	4	1	<1	1	2	<2	<1	7	2	2	2	16	4	3
June 23, 1984	7	3	8	5	60	9	<2	21	3	1	13	8	6	4
June 28, 1984	3	2	<1	6	7	<3	<3	14	2	4	28	33	10	5
July 1, 1984	<1	<1	1	2	<1	<1	<2	4	2	<1	<1	2	<2	<4
July 6, 1984	1	<1	1	<1	<1	<1	<2	5	1	<1	2	1	<2	<4
July 9, 1984	2	1	7	3	3	3	<2	3	<1	<1	3	2	<2	<3
July 14, 1984	5	7	3	<1	12	<4	<2	3	3	<1	2	11	<3	<3
July 19, 1984	<1	<1	1	<1	<1	<1	<2	<1	1	<1	3	1	<1	<3
July 22, 1984	<1	1	3	3	2	<2	<2	12	5	3	<1	11	<5	<3
July 27, 1984	<1	4	2	<1	12	<2	<2	3	2	<1	3	6	<3	<3
July 30, 1984	4	1	1	2	1	2	<1	4	2	1	2	1	<2	<2
Aug. 4, 1984	6	·	2	1	1	2	<2	2		4	2	17	4	<2
Aug. 9, 1984	<1	<1	<1	3	3	<2	<2	2	1	<1	6	4	<2	<2
Aug. 12, 1984	3	1	<1	1	<1	<1	<2	<1	<1	<1	9	3	<2	<2
Aug. 17, 1984	<1	<1	<1	<1	<1	<1	<1	113	1	<1	1	18	<5	<3
Aug. 20, 1984	<1	<1	2	<1	<1	<1	<2	3	3	3	1	4	3	<3
Aug. 25, 1984	<1	<1	<1	1	<1	<1	<1	2	3	1	1	3	2	<2
Aug. 29, 1984	23	8	9	22	20	15	<2	8	8	3	4	10	6	<3
Sept. 2, 1984	<1	1	2	<1	<1	<1	<2	<1	2	<1	<1	17	<2	<3

Table 3b: Field observations recorded during the microbiological sample collections at Star Beach, Star Lake, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
June 15, 1984	10:10	17	18	offshore	90	light	none	none	clear	0	clear	
June 18, 1984	11:10	18	21	offshore	90	none	none	none	clear	0	clear	
June 23, 1984	9:10	17	21	offshore	20	moderate	none	none	clear	0	light	
June 28, 1984	11:20	20	23	onshore	0	none	light	none	clear	2	light	
July 1, 1984	9:20	16	22	offshore	100	light	none	none	clear	0	light	
July 6, 1984	11:00	18	23	offshore	10	none	light	none	clear	2	light	
July 9, 1984	9:15	18	23	offshore	10	none	none	none	clear	2	clear	
July 14, 1984	10:50	22	24	offshore	0	light	light	none	clear	4	light	
July 19, 1984	9:10	17	21	onshore	0	none	none	moderate	clear	0	light	
July 22, 1984	10:20	23	24	offshore	60	none	light	none	clear	6	moderate	
July 27, 1984	9:10	20	23	onshore	0	none	none	none	clear	0	light	
July 30, 1984	10:55	23	24	offshore	100	light	moderate	none	clear	4	light	
Aug. 4, 1984	9:20	23	23	offshore	10	none	light	none	clear	0	light	
Aug. 9, 1984	11:00	21	23	offshore	90	light	light	none	clear	0	light	
Aug. 12, 1984	9:05	18	23	offshore	10	none	none	none	clear	0	light	
Aug. 17, 1984	11:00	21	22	onshore	10	none	light	moderate	clear	0	light	
Aug. 20, 1984	11:10	19	-	onshore	100	heavy	none	none	slight	0	light	
Aug. 25, 1984	10:30	21	22	offshore	0	none	light	none	clear	3	light	
Aug. 29, 1984	10:40	15	21	offshore	100	none	light	none	slight	0	clear	
Sept. 2, 1984	-	-	-	-	-	-	-	-	-	-	-	

The fecal coliform individual maximum objective and the 30-day geometric mean objective were not exceeded during the investigation. A single enterococcus individual maximum objective exceedence was recorded on August 17, 1984. However, the enterococci 30-day geometric mean objective was not exceeded during the investigation.

The single enterococci individual maximum objective exceedence should not have significantly impaired the recreational water quality of Star Beach, Star Lake. Variations in indicator organism densities were not correlated ($P_\alpha = 0.05$) with environmental conditions observed at the times of sample collections.

3.1.4 West Hawk Beach, West Hawk Lake

Microbiological indicator organism population densities at West Hawk Beach, West Hawk Lake are located in Table 4a. Table 4b contains related environmental conditions observed at the times of sample collections.

Fecal coliform densities did not exceed the individual maximum or the 30-day geometric mean objectives during the investigation. Enterococcus organisms exceeded the individual maximum objective in two samples collected in August, 1984. However, exceedences of the 30-day geometric mean objective were not observed. The isolated excursions of the individual maximum objective should not have significantly altered the quality of recreational water at West Hawk Beach, West Hawk Lake.

Such exceedences were not correlated ($P_\alpha = 0.05$) with observed environmental field conditions.

Table 4a: Fecal coliform and enterococcus characteristics of West Hawk Beach, West Hawk Lake, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 17, 1984	<100	<100	<100	<100	<100	<100	<100	<1	<1	<1	<1	<1	<1	<1
June 2, 1984	<1	<1	<1	<1	<1	<1	<10	<1	<1	<1	<1	<1	<1	<1
June 7, 1984	1	<1	<1	<1	<1	<1	<5	<1	1	1	<1	1	<1	<1
June 10, 1984	4	2	<1	1	1	<2	<4	38	42	39	29	21	33	<2
June 15, 1984	<1	<1	<1	<1	<1	<1	<3	<1	<1	2	2	<1	<1	<2
June 18, 1984	<1	4	<1	2	2	<2	<3	9	12	10	8	11	10	<3
June 23, 1984	1	<1	<1	<1	2	<1	<1	5	2	5	3	8	4	<3
June 28, 1984	3	<1	1	<1	<1	<1	<1	6	1	8	11	4	5	<4
July 1, 1984	1	<1	<1	2	<1	<1	<1	3	1	10	2	6	3	<4
July 6, 1984	2	1	1	1	1	<1	<1	6	6	4	4	4	5	<4
July 9, 1984	1	<1	<1	<1	<1	<1	<1	6	6	2	11	9	6	<5
July 14, 1984	3	1	<1	1	<1	<1	<1	16	8	7	22	10	11	<5
July 19, 1984	<1	2	<1	<1	<1	<1	<1	4	3	<1	3	2	<2	<5
July 22, 1984	1	1	61	4	3	4	<1	30	4	28	61	55	26	<6
July 27, 1984	1	3	1	<1	2	<1	<1	5	2	7	5	10	5	<6
July 30, 1984	9	<1	1	<1	97	<4	<2	7	4	5	3	3	4	<6
Aug. 4, 1984	1	1	2	1	22	2	<2	9	9	14	18	74	17	<7
Aug. 9, 1984	10	7	13	6	2	6	<2	8	5	6	4	10	6	<7
Aug. 12, 1984	2	1	<1	1	<1	<1	<2	<1	170	1	2	3	<4	<7
Aug. 17, 1984	8	1	3	<1	<1	<2	<2	19	3	49	10	112	20	<8
Aug. 20, 1984	4	8	<1	<1	<1	<2	<2	7	3	1	<1	<1	<2	<7
Aug. 25, 1984	<1	<1	<1	<1	<1	<1	<2	3	4	7	5	1	3	<6
Aug. 29, 1984	<1	<1	1	1	<1	<1	<1	5	3	2	1	1	2	<5
Sept. 2, 1984	<1	<1	<1	<1	<1	<1	<2	1	1	<1	1	1	<1	<4

Table 4b: Field observations recorded during the microbiological sample collections at West Hawk Beach, West Hawk Lake, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 17, 1984	9:40	20	9	offshore	30	light	none	none	clear	0	clear	
June 2, 1984	10:50	20	9	offshore	30	none	none	none	clear	8	clear	
June 7, 1984	11:25	17	11	onshore	30	heavy	none	none	clear	0	clear	
June 10, 1984	12:25	8	13	onshore	25	light	none	none	slight	0	clear	
June 15, 1984	9:40	17	13	offshore	90	light	none	none	clear	0	clear	
June 18, 1984	10:40	17	18	onshore	90	none	none	light	clear	0	clear	
June 23, 1984	9:30	18	17	offshore	10	moderate	none	none	clear	2	clear	
June 28, 1984	10:45	20	20	onshore	0	none	none	none	clear	8	clear	
July 1, 1984	9:40	17	19	offshore	100	light	none	none	clear	0	clear	
July 6, 1984	10:40	18	20	offshore	10	none	none	none	clear	6	clear	
July 9, 1984	9:30	18	21	onshore	10	none	none	none	clear	6	clear	
July 14, 1984	10:20	21	22	offshore	0	light	none	none	clear	250	clear	
July 19, 1984	9:30	18	21	onshore	0	none	none	moderate	clear	0	clear	
July 22, 1984	10:00	23	21	onshore	60	none	none	none	clear	35	clear	
July 27, 1984	9:30	20	22	onshore	0	none	none	none	clear	4	clear	
July 30, 1984	10:30	23	21	offshore	90	light	none	none	clear	4	clear	
Aug. 4, 1984	9:40	23	23	offshore	10	none	none	none	clear	20	clear	
Aug. 9, 1984	10:30	20	23	offshore	90	light	none	light	clear	0	clear	
Aug. 12, 1984	9:25	19	22	offshore	10	none	none	none	clear	0	clear	
Aug. 17, 1984	10:40	20	22	onshore	10	none	light	moderate	clear	6	clear	
Aug. 20, 1984	11:30	19	-	-	100	heavy	none	none	clear	0	clear	
Aug. 25, 1984	10:10	21	21	offshore	0	none	none	none	clear	8	clear	
Aug. 29, 1984	10:55	17	21	onshore	100	none	none	none	clear	0	clear	
Sept. 2, 1984	-	-	-	-	-	-	-	-	-	-	-	

3.1.5 Caddy Beach, Caddy Lake

Fecal coliform, enterococci and concomitant field conditions for Caddy Beach, Caddy Lake are recorded in Tables 5a and 5b, respectively. Sampling was discontinued after June 10, 1984 in order that efforts could be concentrated towards more heavily utilized beaches.

The 30-day geometric mean objectives for fecal coliform and enterococcus organisms were not exceeded during the limited study period. However, a single enterococcus individual maximum objective exceedence was recorded on June 7, 1984. This single value could not be accounted for by any unusual observed field condition recorded at the time of sampling and likely did not represent a significantly increased health risk to bathers.

3.1.6 Betula Beach, Betula Lake

Fecal coliform and enterococcus densities at Betula Beach, Betula Lake are recorded in Table 6a and the associated field observations are located in Table 6b. The respective 30-day geometric mean objectives for both fecal coliform and enterococci organisms were not exceeded during the study period. As well, exceedences of the fecal coliform individual maximum objective were not observed. However, a single enterococci individual maximum exceedence was observed on August 12, 1984. The geometric mean of other enterococci analyses collected at the same time was 17 organisms/100 mL. This single exceedence should therefore not have represented a significantly increased health risk to bathers. This exceedence was not correlated ($P\alpha = 0.05$) with environmental conditions observed at the times of sample collections.

Table 5a: Fecal coliform and enterococcus characteristics of Caddy Beach, Caddy Lake, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 17, 1984	<100	<100	<100	<100	<100	<100	<100	<1	17	<1	<1	<1	<2	<2
June 2, 1984	<1	2	2	<1	<1	<1	<11	1	<1	<1	<1	<1	<1	<1
June 7, 1984	144	157	132	125	150	141	<27	111	96	95	69	83	90	<5
June 10, 1984	13	17	12	10	6	11	<21	43	26	44	26	27	32	<8

Table 5b: Field observations recorded during the microbiological sample collections at Caddy Beach, Caddy Lake, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 17, 1984	10:40	20	13	offshore	10	light	none	none	clear	0	clear	
June 2, 1984	10:10	20	16	offshore	30	none	none	none	clear	0	clear	
June 7, 1984	12:05	20	18	offshore	25	heavy	light	none	slight	0	clear	
June 10, 1984	12:00	8	17	onshore	25	light	light	none	slight	0	clear	

Table 6a: Fecal coliform and enterococcus characteristics of Betula Beach, Betula Lake, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 17, 1984	<100	<100	<100	<100	<100	<100	<100	7	-	1	<1	1	<2	<2
June 2, 1984	9	6	8	2	5	5	<23	<1	1	2	2	<1	<1	<1
June 7, 1984	5	6	3	2	1	3	<11	13	15	8	7	4	8	<3
June 10, 1984	6	4	7	13	7	7	<10	10	3	2	8	8	5	<3
June 15, 1984	<1	5	<1	1	<1	<1	<8	18	71	25	6	12	19	<5
June 18, 1984	2	1	1	1	7	2	<5	8	5	2	4	2	4	<4
June 23, 1984	17	3	2	14	27	8	<4	81	25	34	76	47	48	<8
June 28, 1984	8	2	9	3	8	5	<4	33	10	22	<1	4	<8	<8
July 1, 1984	4	<1	3	<1	<1	<2	<3	25	6	3	6	8	7	<8
July 6, 1984	4	<1	6	2	16	<4	<3	5	14	16	28	38	16	<10
July 9, 1984	1	3	<1	8	<1	<2	<3	28	13	16	3	5	10	<11
July 14, 1984	3	24	3	2	<1	<3	<3	33	37	12	11	19	20	<12
July 19, 1984	17	55	59	55	39	41	<4	20	11	16	15	6	13	<12
July 22, 1984	3	4	<1	1	<1	<2	<4	4	2	42	30	3	8	<13
July 27, 1984	15	18	22	4	25	14	<5	44	31	21	30	21	28	<12
July 30, 1984	<1	<1	1	<1	<1	<1	<4	8	12	10	5	8	8	12
Aug. 4, 1984	4	<1	<1	<1	<1	<1	<4	33	59	38	31	34	38	15
Aug. 9, 1984	<1	1	3	<1	<1	<1	<3	12	5	5	7	10	7	14
Aug. 12, 1984	109	195	8	9	50	38	<5	9	10	9	12	147	17	15
Aug. 17, 1984	8	6	4	9	9	7	<5	15	44	49	28	27	30	15
Aug. 20, 1984	2	<1	1	1	<1	<1	<3	7	7	6	11	4	7	14
Aug. 25, 1984	<1	<1	<1	1	1	<1	<3	19	14	24	19	20	19	16
Aug. 29, 1984	1	<1	1	<1	4	<1	<2	3	3	3	2	28	4	13
Sept. 2, 1984	<1	<1	<1	2	<1	<1	<2	5	<1	1	2	9	<2	11

Table 6b: Field observations recorded during the microbiological sample collections at Betula Beach, Betula Lake, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 17, 1984	10:35	23	14	offshore	10	none	none	none	clear	0	clear	
June 2, 1984	9:30	18	16	offshore	20	none	light	none	clear	0	clear	
June 7, 1984	13:15	20	17	-	75	heavy	light	none	slight	0	light	
June 10, 1984	10:50	8	16	onshore	0	light	moderate	light	moderate	0	clear	
June 15, 1984	11:20	18	19	offshore	90	light	none	none	clear	0	clear	
June 18, 1984	9:20	16	20	onshore	90	none	none	light	clear	0	clear	
June 23, 1984	11:00	16	17	onshore	100	moderate	none	crests	moderate	0	light	
June 28, 1984	9:40	18	22	onshore	0	none	none	light	clear	2	clear	
July 1, 1984	10:40	20	24	offshore	30	light	none	none	clear	2	light	
July 6, 1984	9:05	17	20	onshore	10	none	none	light	clear	0	light	
July 9, 1984	11:00	22	22	offshore	10	none	none	none	clear	22	clear	
July 14, 1984	9:00	18	23	onshore	0	light	none	none	clear	0	light	
July 19, 1984	11:00	19	24	onshore	20	none	none	light	clear	3	light	
July 22, 1984	9:10	22	24	offshore	60	none	none	none	clear	6	clear	
July 27, 1984	11:00	22	24	onshore	0	none	moderate	none	clear	30	light	
July 30, 1984	9:10	22	23	offshore	90	light	light	none	clear	3	clear	
Aug. 4, 1984	10:40	25	24	offshore	10	none	moderate	none	clear	40	light	
Aug. 9, 1984	9:10	19	23	offshore	90	light	none	light	clear	2	light	
Aug. 12, 1984	10:40	20	22	offshore	10	none	moderate	light	clear	12	light	
Aug. 17, 1984	9:30	18	22	offshore	10	none	light	light	clear	0	moderate	
Aug. 20, 1984	12:40	19	-	-	100	heavy	none	none	slight	0	clear	
Aug. 25, 1984	9:00	20	22	offshore	0	none	light	none	clear	0	light	
Aug. 29, 1984	12:00	15	21	onshore	90	none	none	none	slight	0	clear	
Sept. 2, 1984	-	-	-	-	-	-	-	-	-	-	-	

3.1.7 Nutimik Beach, Nutimik Lake

Tables 7a and 7b contain measured fecal coliform and enterococcus densities and associated environmental conditions, respectively, at Nutimik Beach, Nutimik Lake.

Both fecal coliform individual maximum objectives and 30-day geometric mean objectives were not exceeded during the investigation. The individual maximum objective for enterococcus population densities was exceeded on three sampling periods. However, the 30-day geometric mean objective for this indicator group was not exceeded. Thus, these individual maximum objective exceedences should not have resulted in a significantly increased health risk to bathers.

Variations in bacterial population densities were not correlated ($P\alpha = 0.05$) with recorded field conditions.

3.1.8 Dorothy Beach, Dorothy Lake

Microbiological data and associated field observations recorded at Dorothy Beach, Dorothy Lake are located in Tables 8a and 8b, respectively.

The 30-day geometric mean values for both fecal coliforms and enterococci did not exceed the recommended objectives. As well, the individual maximum objective for fecal coliform organisms was not exceeded. However, the individual maximum objective for enterococci was exceeded on four occasions. These isolated exceedences should not have represented a significantly increased health risk to bathers.

The enterococci exceedences were not correlated ($P\alpha = 0.05$) with environmental conditions recorded at the times of sampling.

Table 7a: Fecal coliform and enterococcus characteristics of Nutimik Beach, Nutimik Lake, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 17, 1984	<100	<100	<100	<100	<100	<100	<100	1	<1	<1	3	<1	<1	<1
June 2, 1984	1	<1	<1	2	2	<1	<11	<1	2	1	1	3	<1	<1
June 7, 1984	2	<1	5	4	4	<3	<7	33	8	5	12	3	9	<2
June 10, 1984	298	2	11	7	2	10	<8	100	10	33	23	10	24	<4
June 15, 1984	1	2	1	<1	9	<2	<6	9	16	9	7	15	11	<5
June 18, 1984	1	5	4	1	2	2	<5	16	12	16	11	19	15	<6
June 23, 1984	106	84	84	74	89	87	<5	143	132	107	129	139	129	<13
June 28, 1984	1	<1	1	<1	1	<1	<4	7	7	5	6	2	5	<12
July 1, 1984	<1	1	1	1	<1	<1	<3	33	25	25	2	11	14	<12
July 6, 1984	<1	<1	<1	<1	<1	<1	<3	3	4	7	9	1	4	13
July 9, 1984	<1	<1	<1	<1	1	<1	<3	3	1	1	2	1	1	11
July 14, 1984	<1	<1	4	<1	2	<2	<2	9	17	6	26	18	13	10
July 19, 1984	2	<1	3	1	4	<2	<2	262	105	115	138	85	130	14
July 22, 1984	<1	<1	<1	<1	<1	<1	<2	19	35	31	42	11	25	15
July 27, 1984	<1	<1	<1	<1	2	<1	<1	14	10	5	4	8	7	10
July 30, 1984	1	4	1	<1	2	<2	<1	40	26	4	9	6	12	11
Aug. 4, 1984	<1	<1	<1	2	3	<1	<1	65	30	48	28	75	46	13
Aug. 9, 1984	<1	1	4	2	1	<2	<1	10	19	15	51	2	12	15
Aug. 12, 1984	<1	1	<1	<1	<1	<1	<1	3	1	2	2	1	2	16
Aug. 17, 1984	<1	<1	<1	<1	2	<1	<1	4	5	28	21	22	12	15
Aug. 20, 1984	<1	<1	1	5	1	<1	<1	4	4	2	5	2	3	10
Aug. 25, 1984	<1	<1	<1	<1	<1	<1	<1	1	4	1	6	4	3	7
Aug. 29, 1984	6	2	6	6	5	5	<1	14	10	12	24	20	15	8
Sept. 2, 1984	<1	1	1	<1	1	<1	<1	<1	4	1	1	5	<2	<6

Table 7b: Field observations recorded during the microbiological sample collections at Nutimik Beach, Nutimik Lake, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 17, 1984	12:00	24	13	onshore	10	none	none	light	clear	0	clear	
June 2, 1984	9:00	17	12	offshore	0	none	none	none	clear	0	clear	
June 7, 1984	13:47	21	14	offshore	80	heavy	none	none	clear	0	clear	
June 10, 1984	10:20	8	14	onshore	20	light	light	light	clear	0	clear	
June 15, 1984	11:45	20	15	offshore	90	none	none	none	clear	0	clear	
June 18, 1984	8:50	16	17	onshore	90	none	none	light	clear	0	clear	
June 23, 1984	11:30	16	18	onshore	100	moderate	none	heavy	moderate	0	light	
June 28, 1984	9:20	17	18	onshore	0	none	none	none	clear	0	clear	
July 1, 1984	11:20	21	21	offshore	30	light	none	none	clear	2	clear	
July 6, 1984	8:40	16	19	onshore	10	light	none	light	clear	0	clear	
July 9, 1984	11:20	22	21	offshore	10	none	none	none	clear	0	clear	
July 14, 1984	8:40	18	21	onshore	0	light	none	none	clear	0	clear	
July 19, 1984	11:20	20	21	onshore	20	none	light	light	clear	4	light	
July 22, 1984	8:50	20	22	offshore	60	none	none	none	clear	0	clear	
July 27, 1984	11:20	22	24	onshore	0	none	light	none	clear	4	light	
July 30, 1984	8:50	22	24	offshore	90	light	light	none	clear	0	clear	
Aug. 4, 1984	11:05	26	23	offshore	10	none	light	none	clear	35	light	
Aug. 9, 1984	8:50	18	23	offshore	90	light	none	light	clear	0	light	
Aug. 12, 1984	11:00	21	23	offshore	10	none	light	none	clear	22	light	
Aug. 17, 1984	9:10	18	23	offshore	10	none	light	light	clear	0	moderate	
Aug. 20, 1984	13:05	19	-	-	100	heavy	light	none	clear	0	clear	
Aug. 25, 1984	8:40	19	22	offshore	0	none	light	none	clear	0	light	
Aug. 29, 1984	12:20	15	21	onshore	95	none	none	light	clear	0	clear	
Sept. 2, 1984	-	-	-	-	-	-	-	-	-	-	-	

Table 8a: Fecal coliform and enterococcus characteristics of Dorothy Beach, Dorothy Lake, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 17, 1984	<100	<100	<100	<100	<100	<100	<100	3	<1	<1	2	<1	<1	<1
June 2, 1984	32	62	34	33	12	31	<55	2	<1	5	3	2	<2	<2
June 7, 1984	3	6	<1	9	5	<4	<23	30	83	13	29	21	29	<5
June 10, 1984	4	2	<1	3	2	<2	<13	11	11	10	15	14	12	<6
June 15, 1984	4	5	6	1	4	3	<10	5	5	7	8	28	8	<6
June 18, 1984	7	5	6	1	3	4	<8	53	52	44	28	32	40	<9
June 23, 1984	<1	35	31	34	17	<14	<6	160	151	184	140	70	134	<18
June 28, 1984	<1	1	<1	1	1	<1	<5	7	6	3	7	9	6	<15
July 1, 1984	11	3	2	<1	1	<2	<4	46	29	21	19	24	26	<17
July 6, 1984	1	<1	1	<1	<1	<1	<3	13	2	18	9	5	7	19
July 9, 1984	<1	<1	<1	<1	<1	<1	<2	32	14	14	11	7	14	17
July 14, 1984	<1	5	12	6	7	<5	<3	114	77	101	118	72	94	23
July 19, 1984	<1	8	19	33	45	<12	<3	136	36	46	91	131	77	30
July 22, 1984	<1	<1	<1	1	3	<1	<3	22	20	23	16	28	21	28
July 27, 1984	<1	2	1	7	30	<3	<2	31	15	9	27	13	17	21
July 30, 1984	<1	2	<1	<1	<1	<1	<2	5	7	5	6	10	6	21
Aug. 4, 1984	<1	2	3	1	17	<3	<2	21	7	70	62	83	35	22
Aug. 9, 1984	2	2	1	1	<1	<1	<2	4	11	10	8	9	8	22
Aug. 12, 1984	9	1	<1	<2	<1	<2	<3	3	1	2	26	2	3	19
Aug. 17, 1984	3	4	1	2	2	2	<2	140	6	3	5	4	9	14
Aug. 20, 1984	<1	<1	<1	1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<8
Aug. 25, 1984	1	<1	2	<1	<1	<1	<2	<1	3	1	1	2	<1	<6
Aug. 29, 1984	1	2	<1	1	2	<1	<1	4	9	4	3	8	5	<5
Sept. 2, 1984	<1	<1	<1	<1	<1	<1	<1	4	<1	<1	4	1	<2	<4

Table 8b: Field observations recorded during the microbiological sample collections at Dorothy Beach, Dorothy Lake, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 17, 1984	12:35	24	12	onshore	10	none	none	light	clear	0	clear	
June 2, 1984	8:35	17	13	onshore	0	none	none	light	clear	0	clear	
June 7, 1984	14:20	21	15	onshore	80	heavy	none	none	clear	0	clear	
June 10, 1984	10:45	7	14	onshore	10	light	none	none	clear	0	clear	
June 15, 1984	12:15	20	16	offshore	90	none	none	none	clear	0	clear	
June 18, 1984	8:30	16	16	onshore	60	none	none	moderate	clear	0	clear	
June 23, 1984	11:55	16	17	onshore	100	moderate	none	heavy	moderate	0	light	
June 28, 1984	8:50	17	19	onshore	0	none	none	none	clear	0	clear	
July 1, 1984	11:50	21	21	offshore	20	light	none	none	clear	4	clear	
July 6, 1984	8:20	16	19	onshore	10	light	none	light	clear	0	clear	
July 9, 1984	11:45	22	24	onshore	10	none	none	light	clear	0	clear	
July 14, 1984	8:20	17	20	onshore	0	light	none	none	clear	0	moderate	
July 19, 1984	11:40	20	22	onshore	20	none	light	none	clear	5	clear	
July 22, 1984	8:30	20	21	offshore	60	none	none	none	clear	0	light	
July 27, 1984	11:40	22	24	onshore	0	none	moderate	none	clear	6	light	
July 30, 1984	8:30	22	23	offshore	90	light	light	none	clear	0	clear	
Aug. 4, 1984	11:30	26	24	offshore	10	none	light	none	clear	0	light	
Aug. 9, 1984	8:30	18	23	offshore	90	light	none	light	clear	0	light	
Aug. 12, 1984	11:25	22	23	offshore	10	none	light	light	clear	8	light	
Aug. 17, 1984	8:50	17	22	offshore	10	none	light	light	clear	0	light	
Aug. 20, 1984	13:30	19	-	-	100	heavy	none	none	slight	0	clear	
Aug. 25, 1984	8:20	18	22	offshore	0	none	light	none	clear	0	light	
Aug. 29, 1984	13:00	16	21	onshore	90	none	light	light	clear	0	clear	
Sept. 2, 1984	-	-	-	-	-	-	-	-	-	-	-	

As with other study beaches located within the Whiteshell Provincial Park, Dorothy Beach, Dorothy Lake displayed excellent microbiological quality with respect to recreational water quality objectives.

3.2 East Side Lake Winnipeg Beaches

3.2.1 Victoria Beach (Club House Area), Lake Winnipeg

Fecal coliform and enterococcus characteristics at Victoria Beach (Club House Area), Lake Winnipeg are located in Table 9a. Associated field conditions observed during sample collections are recorded in Table 9b.

Occasional exceedences of individual maximum objectives were observed for both fecal coliform and enterococcus organisms during the study period. However, excursions of the respective 30-day geometric mean objectives were not observed. Such individual maximum objective exceedences should not have significantly impaired the recreational quality of this area of Victoria Beach, Lake Winnipeg.

Indicator organism density variations were not correlated ($P\alpha = 0.05$) with environmental factors recorded at the times of sample collections.

Table 9a: Fecal coliform and enterococcus characteristics of Victoria Beach (Club House), Lake Winnipeg, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
June 21, 1984	<100	<100	<100	<100	<100	<100	<100	18	12	38	30	31	24	24
June 24, 1984	<100	<100	<100	<100	<100	<100	<100	35	40	48	38	33	38	30
June 29, 1984	<100	<100	<100	<100	<100	<100	<100	31	21	38	14	14	22	27
July 2, 1984	<100	<100	<100	<100	<100	<100	<100	5	11	14	14	7	9	21
July 7, 1984	<100	<100	<100	<100	<100	<100	<100	9	10	12	20	23	14	19
July 12, 1984	<100	<100	<100	<100	<100	<100	<100	67	63	44	36	26	44	22
July 15, 1984	300	700	400	300	200	347	<119	111	120	108	121	119	116	28
July 20, 1984	200	100	<100	<100	<100	<115	<119	45	21	26	38	62	36	29
July 23, 1984	<100	<100	<100	200	<100	<115	<121	21	22	20	9	8	15	27
July 28, 1984	<100	100	200	400	400	<200	<132	31	41	46	50	70	46	28
Aug. 2, 1984	<100	<100	<100	<100	<100	<100	<132	21	7	8	20	57	17	27
Aug. 5, 1984	<100	<100	100	<100	<100	<100	<132	29	21	18	29	32	25	30
Aug. 10, 1984	<100	<100	<100	<100	<100	<100	<132	2	2	40	2	4	4	26
Aug. 13, 1984	<100	<100	<100	<100	<100	<100	<132	1	>300	6	12	7	>11	>22
Aug. 18, 1984	<100	<100	<100	<100	<100	<100	<113	8	6	12	14	12	10	>16
Aug. 23, 1984	<100	<100	<100	<100	<100	<100	<111	24	44	72	78	114	58	>17
Aug. 26, 1984	100	<100	<100	<100	<100	<100	<110	26	19	29	23	25	24	>18
Aug. 30, 1984	<100	<100	<100	100	<100	<100	<100	128	122	106	64	126	106	>20
Sept. 3, 1984	<100	<100	<100	<100	<100	<100	<100	80	84	50	38	54	59	>24

Table 9b: Field observations recorded during the microbiological sample collections at Victoria Beach (Club House), Lake Winnipeg, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
June 21, 1984	12:00	21	21	onshore	90	none	light	light	slight	0	clear	
June 24, 1984	9:50	17	18	onshore	10	none	none	heavy	extensive	0	light	
June 29, 1984	12:00	23	22	onshore	0	none	light	crests	extensive	9	light	
July 2, 1984	9:20	20	21	onshore	20	light	light	heavy	extensive	3	light	
July 7, 1984	12:25	20	21	onshore	10	none	none	heavy	extensive	10	light	
July 12, 1984	9:30	19	25	onshore	70	none	light	light	moderate	0	light	
July 15, 1984	12:00	20	22	onshore	10	light	light	heavy	extensive	6	light	
July 20, 1984	9:50	18	22	onshore	30	none	light	light	moderate	0	light	
July 23, 1984	11:50	21	23	onshore	10	none	light	heavy	extensive	6	light	
July 28, 1984	9:50	20	23	onshore	20	none	light	moderate	moderate	4	light	
Aug. 2, 1984	12:15	24	24	offshore	0	none	moderate	none	slight	40	light	
Aug. 5, 1984	9:30	23	23	onshore	10	none	light	moderate	moderate	8	light	
Aug. 10, 1984	12:30	19	23	offshore	50	none	moderate	light	moderate	24	light	
Aug. 13, 1984	9:45	19	23	offshore	10	none	moderate	none	slight	0	light	
Aug. 18, 1984	14:45	24	24	onshore	0	none	light	none	slight	-	light	
Aug. 23, 1984	9:40	11	21	onshore	10	none	light	heavy	extensive	0	light	
Aug. 26, 1984	11:20	24	22	onshore	20	light	light	moderate	moderate	10	light	
Aug. 30, 1984	10:15	11	19	onshore	50	none	light	heavy	slight	0	light	
Sept. 3, 1984	-	-	-	-	-	-	-	-	-	-	-	

3.2.2 Victoria Beach (Ski Dock Area), Lake Winnipeg

Fecal coliform and enterococcus indicator organisms as well as the population densities of the pathogens P. aeruginosa and S. aureus measured at Victoria Beach, Lake Winnipeg in the vicinity of the Ski Dock Area are located in Table 10a. Relevant field observations recorded during sample collections are located in Table 10b.

Fecal coliform individual maximum objective exceedences were occasionally observed throughout the duration of the study period. However, fecal coliform organism densities did not exceed the 30-day geometric mean objective.

Enterococci population densities showed considerably more variation than fecal coliform organism densities. Numerous exceedences of the enterococci individual maximum objective were observed. Additionally, the 30-day geometric mean objective was exceeded by one unit during the 30-day period ending on July 23, 1984. This exceedence however, should not have significantly impaired the recreational quality of this region of Victoria Beach, Lake Winnipeg.

The specific pathogens P. aeruginosa and S. aureus were isolated in 16% and 28% respectively, of the samples collected. However, individual densities were very low on these occasions. While the occasional presence of these bacteria indicate a potential risk of infections of the eyes, ears, nose and throat, such low pathogen densities probably represented a minimal additional risk of contracting such infections while bathing.

Table 10a: Fecal coliform, enterococcus, *Pseudomonas aeruginosa* and *Staphylococcus aureus* characteristics of Victoria Beach (Ski Dock Area), Lake Winnipeg, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	6	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	6	Geo. Mean	30-Day Geo. Mean	*Pseudomonas aeruginosa*	*Staphylococcus aureus*
May 15, 1984	<100	<100	<100	<100	<100	<100	<100	<100	9	3	16	12	5	3	7	7	0	<1
May 31, 1984	100	200	<100	100	<100	600	<151	<123	65	45	97	93	90	12	55	19	0	<1
June 3, 1984	<100	<100	100	<100	200	<100	<112	<119	2	5	2	4	2	4	3	10	0	<1
June 8, 1984	<100	<100	<100	<100	<100	<100	<100	<114	2	3	<1	5	<1	8	<2	<7	0	<2
June 11, 1984	<100	<100	<100	<100	<100	<100	<100	<111	10	13	11	27	2	6	9	<7	0	<1
June 16, 1984	<100	<100	<100	<100	<100	<100	<100	<111	11	11	4	12	17	1	7	<8	0	<1
June 21, 1984	<100	100	<100	<100	<100	<100	<100	<109	28	42	43	>300	37	20	>47	><10	0	<1
June 24, 1984	<100	100	<100	<100	<100	<100	<100	<108	14	13	17	[illegible]	17	30	15	><11	0	<2
June 29, 1984	<100	100	<100	100	<100	<100	<100	<107	>300	208	223	205	21	6	>84	><14	0	<2
July 2, 1984	100	100	<100	<100	<100	100	<100	<105	52	70	67	21	9	31	34	><13	3	<1
July 7, 1984	<100	<100	<100	<100	<100	<100	<100	<104	110	62	66	108	92	16	64	><19	0	<1
July 12, 1984	<100	<100	<100	<100	<100	<100	<100	<104	15	15	35	12	25	4	15	>24	0	<1
July 15, 1984	300	<100	700	200	<100	<100	<187	<112	137	120	131	127	125	75	117	>33	0	<1
July 20, 1984	100	<100	<100	100	200	<100	<112	<114	185	104	>300	>300	>300	10	>132	>48	0	<1
July 23, 1984	<100	100	200	100	100	<100	<112	<116	72	106	88	89	88	36	76	>51	0	13
July 28, 1984	<100	<100	<100	<100	<100	<100	<100	<116	34	8	10	13	18	5	12	>50	0	<1
Aug. 2, 1984	<100	<100	<100	<100	<100	<100	<100	<116	19	6	162	52	125	16	35	>45	0	<1
Aug. 5, 1984	<100	<100	<100	<100	<100	<100	<100	<116	20	18	19	27	45	7	20	>42	0	4
Aug. 10, 1984	<100	<100	<100	<100	<100	<100	<100	<116	80	34	54	60	100	10	45	>40	0	2
Aug. 13, 1984	<100	<100	<100	100	<100	<100	<100	<116	23	21	8	7	19	32	16	>40	4	<1
Aug. 18, 1984	<100	<100	<100	<100	<100	<100	<100	<107	24	26	4	6	2	16	9	>32	0	8
Aug. 23, 1984	<100	<100	<100	100	<100	<100	<100	<105	68	106	66	74	88	>300	>99	>30	0	<1
Aug. 26, 1984	700	400	100	300	200	<100	<235	<116	87	82	81	67	61	62	73	>30	9	<1
Aug. 30, 1984	300	<100	<100	<100	200	<100	<135	<120	106	118	134	140	184	49	113	>40	0	<1
Sept. 3, 1984	<100	<100	<100	<100	<100	<100	<100	<120	8	6	16	10	20	8	10	>34	9	<1

Table 10b: Field observations recorded during the microbiological sample collections at Victoria Beach (Ski Dock Area), Lake Winnipeg, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 15, 1984	10:15	15	6	onshore	0	none	light	light	moderate	0	light	
May 31, 1984	12:00	22	16	onshore	75	none	light	light	slight	0	light	
June 3, 1984	9:30	17	16	onshore	0	none	none	light	moderate	0	light	
June 8, 1984	9:15	14	15	onshore	100	moderate	none	none	slight	0	clear	
June 11, 1984	11:40	17	16	onshore	0	none	light	moderate	extensive	0	light	
June 16, 1984	8:50	20	17	onshore	10	none	light	light	moderate	0	light	
June 21, 1984	11:40	21	21	onshore	90	none	moderate	light	moderate	0	light	
June 24, 1984	9:30	17	19	offshore	10	none	none	none	moderate	0	clear	
June 29, 1984	11:40	22	23	onshore	0	none	moderate	moderate	extensive	2	light	
July 2, 1984	9:00	20	21	onshore	20	light	light	heavy	extensive	2	light	
July 7, 1984	12:00	20	20	onshore	10	none	none	moderate	extensive	0	light	
July 12, 1984	9:10	19	23	offshore	70	none	moderate	none	moderate	0	light	
July 15, 1984	11:30	20	22	offshore	10	light	light	none	extensive	2	light	
July 20, 1984	9:20	17	22	onshore	30	none	light	light	moderate	0	light	
July 23, 1984	11:30	21	23	onshore	10	none	light	light	extensive	3	light	
July 28, 1984	9:30	20	24	onshore	20	none	light	light	moderate	4	light	
Aug. 2, 1984	11:50	24	24	offshore	0	none	moderate	none	slight	0	light	
Aug. 5, 1984	9:10	22	23	onshore	10	none	light	light	moderate	0	light	
Aug. 10, 1984	12:00	18	23	onshore	0	none	moderate	light	moderate	0	light	
Aug. 13, 1984	9:20	18	22	onshore	10	none	light	light	slight	0	light	
Aug. 18, 1984	14:30	24	24	onshore	0	none	light	none	slight	30	light	
Aug. 23, 1984	9:15	11	21	onshore	10	none	light	moderate	extensive	0	light	
Aug. 26, 1984	11:00	23	21	onshore	20	light	light	light	moderate	0	light	
Aug. 30, 1984	10:00	11	19	onshore	50	none	light	heavy	slight	0	light	
Sept. 3, 1984	-	-	-	-	-	-	-	-	-	-	-	

3.2.3 Hillside Beach, Lake Winnipeg

Indicator bacterial population measurements and associated environmental conditions observed at the times of sampling for Hillside Beach, Lake Winnipeg, are recorded in Tables 11a and 11b, respectively.

Excursions of the respective 30-day geometric mean objectives for fecal coliform and enterococcus organisms were not observed during the study period. However, several isolated exceedences of the individual maximum objective were recorded for enterococci. These exceedences, however, should not have posed a significantly increased health risk to bathers. Such exceedences were not correlated ($P\alpha$ = 0.05) with related environmental factors recorded during sample collections.

3.2.4 Lester Beach, Lake Winnipeg

Fecal coliform and enterococcus indicator organism group densities and associated field observations recorded at Lester Beach, Lake Winnipeg are located in Tables 12a and 12b.

Data are limited for Lester Beach, Lake Winnipeg, since sampling was effectively discontinued after June 16, 1984 in order to concentrate efforts towards more heavily utilized beaches. Exceedences of the individual maximum objective for all five enterococci samples collected on August 30, 1984 resulted in the respective 30-day geometric mean objective being achieved, but not exceeded. The objectives were not exceeded on other sampling occasions.

Table 11a: Fecal coliform and enterococcus characteristics of Hillside Beach, Lake Winnipeg, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 15, 1984	<100	<100	<100	<100	<100	<100	<100	<1	<1	<1	<1	<1	<1	<1
May 31, 1984	<100	<100	<100	<100	<100	<100	<100	1	<1	2	2	<1	<1	<1
June 3, 1984	<100	<100	<100	<100	<100	<100	<100	<1	24	4	2	1	<3	<2
June 8, 1984	<100	<100	<100	100	<100	<100	<100	47	26	24	25	28	29	<3
June 11, 1984	<100	<100	<100	100	<100	<100	<100	12	4	9	8	18	9	<4
June 16, 1984	<100	<100	<100	<100	<100	<100	<100	2	2	1	2	5	2	<5
June 21, 1984	<100	<100	<100	<100	<100	<100	<100	63	89	48	86	49	65	<7
June 24, 1984	<100	100	<100	<100	<100	<100	<100	75	77	84	141	115	95	<10
June 29, 1984	<100	<100	<100	<100	<100	<100	<100	79	24	41	30	28	37	<12
July 2, 1984	100	<100	200	<100	<100	<115	<102	19	8	17	28	30	19	17
July 7, 1984	<100	<100	<100	<100	<100	<100	<102	17	17	39	41	37	28	22
July 12, 1984	<100	<100	100	100	<100	<100	<102	69	29	47	30	39	41	23
July 15, 1984	<100	<100	<100	100	100	<100	<102	54	61	47	70	51	56	29
July 20, 1984	<100	<100	<100	<100	<100	<100	<102	19	28	35	37	77	35	42
July 23, 1984	100	<100	<100	<100	<100	<100	<102	33	41	37	47	332	60	41
July 28, 1984	<100	<100	<100	<100	<100	<100	<102	9	2	7	6	15	6	30
Aug. 2, 1984	<100	<100	<100	<100	<100	<100	<102	19	8	14	5	15	11	25
Aug. 5, 1984	<100	<100	<100	<100	<100	<100	<100	80	7	7	10	14	14	25
Aug. 10, 1984	<100	<100	<100	<100	<100	<100	<100	14	6	6	4	8	7	21
Aug. 13, 1984	<100	<100	<100	<100	<100	<100	<100	>300	67	46	88	78	>91	>23
Aug. 18, 1984	<100	<100	<100	<100	<100	<100	<100	12	6	4	8	4	6	>18
Aug. 23, 1984	<100	<100	<100	<100	<100	<100	<100	2	6	8	4	26	6	>14
Aug. 26, 1984	<100	<100	<100	<100	<100	<100	<100	46	12	24	18	16	21	>16
Aug. 30, 1984	100	<100	<100	<100	<100	<100	<100	38	78	40	68	238	72	>20
Sept. 3, 1984	<100	<100	<100	<100	<100	<100	<100	99	90	34	38	58	58	>24

Table 11b: Field observations recorded during the microbiological sample collections at Hillside Beach, Lake Winnipeg, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 15, 1984	10:45	15	5	offshore	0	none	light	light	moderate	0	light	
May 31, 1984	11:30	23	13	offshore	65	none	light	none	slight	0	light	
June 3, 1984	10:00	19	14	onshore	0	none	none	light	moderate	0	light	
June 8, 1984	10:00	14	14	onshore	100	moderate	none	moderate	slight	0	light	
June 11, 1984	11:00	17	15	onshore	0	none	none	moderate	slight	0	light	
June 16, 1984	9:30	20	18	onshore	10	none	none	light	slight	0	light	
June 21, 1984	11:10	20	21	offshore	90	none	light	none	slight	0	clear	
June 24, 1984	10:20	18	19	onshore	10	none	none	heavy	extensive	0	light	
June 29, 1984	10:50	21	21	offshore	0	none	light	light	moderate	0	light	
July 2, 1984	10:00	21	22	onshore	10	light	light	light	moderate	2	light	
July 7, 1984	11:20	20	20	onshore	20	none	none	light	moderate	0	light	
July 12, 1984	10:00	20	23	onshore	70	none	light	light	moderate	0	light	
July 15, 1984	11:00	20	22	onshore	10	light	light	heavy	extensive	2	light	
July 20, 1984	10:10	20	22	onshore	30	none	light	none	slight	0	light	
July 23, 1984	12:20	22	23	onshore	10	none	light	heavy	extensive	2	light	
July 28, 1984	10:50	22	23	onshore	20	none	light	moderate	moderate	6	light	
Aug. 2, 1984	11:10	25	23	offshore	0	none	light	none	slight	4	light	
Aug. 5, 1984	9:50	23	23	onshore	10	none	moderate	moderate	moderate	6	light	
Aug. 10, 1984	11:30	18	22	onshore	50	none	moderate	light	moderate	6	light	
Aug. 13, 1984	10:15	20	22	offshore	10	none	light	light	slight	1	light	
Aug. 18, 1984	13:50	24	21	onshore	0	none	light	none	slight	10	light	
Aug. 23, 1984	10:05	12	22	onshore	10	none	moderate	light	moderate	0	light	
Aug. 26, 1984	10:30	23	21	onshore	20	light	moderate	light	slight	2	light	
Aug. 30, 1984	11:00	12	19	onshore	60	none	light	heavy	extensive	0	light	
Sept. 3, 1984	-	-	-	-	-	-	-	-	-	-	-	

Table 12a: Fecal coliform and enterococcus characteristics of Lester Beach, Lake Winnipeg, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 15, 1984	<100	<100	<100	<100	<100	<100	<100	<1	<1	<1	<1	<1	<1	<1
May 31, 1984	<100	<100	<100	<100	<100	<100	<100	<1	1	1	1	<1	<1	<1
June 3, 1984	100	<100	<100	<100	<100	<100	<100	6	5	28	3	5	7	<2
June 8, 1984	<100	100	100	<100	<100	<100	<100	32	21	33	15	9	20	<3
June 11, 1984	<100	<100	<100	<100	<100	<100	<100	7	14	9	8	8	9	<4
June 16, 1984	<100	<100	<100	<100	<100	<100	<100	2	7	11	4	2	4	<5
Aug. 18, 1984	<100	<100	<100	<100	<100	<100	<100	2	16	8	62	16	12	12
Aug. 30, 1984	<100	<100	<100	<100	<100	<100	<100	190	234	192	192	218	204	50
Sept. 3, 1984	<100	<100	<100	<100	<100	<100	<100	38	66	30	29	24	35	44

Table 12b: Field observations recorded during the microbiological sample collections at Lester Beach, Lake Winnipeg, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 15, 1984	14:00	20	8	offshore	0	none	light	light	moderate	0	light	
May 31, 1984	10:50	22	15	offshore	45	none	light	none	slight	0	light	
June 3, 1984	11:00	21	16	onshore	0	none	none	light	moderate	3	light	
June 8, 1984	10:50	15	16	onshore	100	moderate	none	moderate	slight	0	light	
June 11, 1984	10:30	16	14	onshore	0	none	none	moderate	moderate	0	light	
June 16, 1984	10:10	20	18	onshore	10	none	none	light	slight	4	clear	
Aug. 18, 1984	1:00	24	24	onshore	0	none	light	light	slight	50	light	
Aug. 30, 1984	11:35	14	19	onshore	50	none	light	heavy	slight	0	light	
Sept. 3, 1984	-	-	-	-	-	-	-	-	-	-	-	

These exceedences therefore, should not have resulted in a significantly increased health risk to bathers. Variations in indicator organisms' densities were not correlated ($P\alpha = 0.05$) with observed environmental conditions.

3.2.5 Grand Beach (East), Lake Winnipeg

Grand Beach (East), Lake Winnipeg microbiological measurements and related field observations are located in Tables 13a and 13b, respectively. Exceedences of the respective individual maximum objectives were recorded for both fecal coliform and enterococci organisms. However, excursions of the respective 30-day geometric mean objectives were not observed. Hence, the individual maximum exceedences should not have represented a significantly increased health risk to bathers.

Such excursions were not correlated ($P\alpha = 0.05$) with related environmental conditions recorded at the times of sample collections.

3.2.6 Grand Beach (West), Lake Winnipeg

Tables 14a and 14b contain the fecal coliform and enterococcus densities, summary calculations and related environmental conditions recorded at Grand Beach (West), Lake Winnipeg, during the study period. Individual maximum objectives for both fecal coliform and enterococcus organisms were exceeded on several occasions during the investigation. Excursions of the 30-day geometric mean

Table 13a: Fecal coliform and enterococcus characteristics of Grand Beach (East), Lake Winnipeg, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 15, 1984	<100	<100	<100	<100	<100	<100	<100	1	<1	<1	<1	<1	<1	<1
May 31, 1984	<100	<100	<100	<100	<100	<100	<100	4	2	2	1	2	2	<1
June 3, 1984	<100	<100	<100	<100	100	<100	<100	3	1	1	3	7	2	<2
June 8, 1984	<100	<100	<100	<100	<100	<100	<100	9	8	6	13	9	9	<3
June 11, 1984	<100	<100	<100	<100	<100	<100	<100	9	14	8	7	16	10	<3
June 16, 1984	<100	<100	<100	<100	<100	<100	<100	1	<1	<1	4	1	<1	<4
June 21, 1984	100	<100	<100	<100	100	<100	<100	18	20	8	>300	>300	>48	><5
June 24, 1984	<100	<100	<100	<100	<100	<100	<100	43	30	44	28	47	38	><7
June 29, 1984	100	<100	<100	<100	<100	<100	<100	8	8	5	1	8	5	><7
July 2, 1984	<100	<100	<100	<100	<100	<100	<100	17	10	7	5	10	9	><8
July 7, 1984	<100	<100	<100	<100	<100	<100	<100	8	6	1	3	8	4	><9
July 12, 1984	300	100	100	100	100	125	<103	146	91	100	113	69	101	><12
July 15, 1984	500	200	<100	<100	200	<182	<111	105	61	76	91	94	84	><16
July 20, 1984	<100	100	<100	<100	<100	<100	<111	23	39	16	19	23	23	>22
July 23, 1984	200	100	100	<100	<100	<115	<113	34	29	19	14	10	19	20
July 28, 1984	<100	<100	<100	<100	<100	<100	<113	9	8	10	6	11	9	17
Aug. 2, 1984	<100	100	<100	<100	<100	<100	<113	58	28	61	14	56	38	21
Aug. 5, 1984	<100	<100	<100	<100	<100	<100	<113	16	10	11	14	11	12	22
Aug. 10, 1984	100	<100	<100	<100	<100	<100	<113	168	114	90	22	30	65	31
Aug. 13, 1984	700	400	300	200	100	279	<125	130	140	63	62	44	79	31
Aug. 18, 1984	<100	<100	<100	<100	<100	<100	<116	6	6	2	14	26	8	23
Aug. 23, 1984	<100	<100	<100	<100	<100	<100	<116	44	16	20	18	28	23	23
Aug. 26, 1984	300	500	100	<100	500	<237	<127	84	43	42	40	34	46	25
Aug. 30, 1984	<100	100	<100	<100	<100	<100	<127	180	140	134	148	134	146	36
Sept. 3, 1984	<100	200	<100	100	100	<115	<129	8	12	12	28	4	11	31

Table 13b: Field observations recorded during the microbiological sample collections at Grand Beach (East), Lake Winnipeg, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 15, 1984	11:30	15	8	offshore	0	none	light	none	moderate	0	light	
May 31, 1984	10:00	21	16	offshore	50	none	light	none	slight	0	light	
June 3, 1984	11:35	22	18	onshore	0	none	none	light	moderate	10	light	
June 8, 1984	11:45	15	16	onshore	100	moderate	light	moderate	moderate	0	light	
June 11, 1984	9:00	15	15	onshore	0	none	none	moderate	moderate	0	light	
June 16, 1984	10:50	21	21	offshore	0	none	none	light	slight	17	clear	
June 21, 1984	9:30	18	17	offshore	90	none	moderate	none	slight	0	clear	
June 24, 1984	11:00	18	22	onshore	10	none	none	heavy	extensive	46	light	
June 29, 1984	9:30	19	20	offshore	0	none	none	none	moderate	3	light	
July 2, 1984	10:30	22	21	onshore	10	light	light	moderate	moderate	45	clear	
July 7, 1984	9:50	17	20	offshore	10	none	none	none	moderate	4	light	
July 12, 1984	11:00	20	23	onshore	50	none	light	light	moderate	12	light	
July 15, 1984	9:40	17	22	onshore	50	light	light	heavy	extensive	0	light	
July 20, 1984	10:50	21	21	onshore	30	none	light	light	moderate	20	light	
July 23, 1984	10:00	20	22	onshore	10	none	light	heavy	extensive	4	light	
July 28, 1984	11:30	23	22	onshore	20	none	light	light	moderate	400	light	
Aug. 2, 1984	10:10	23	23	offshore	0	none	none	none	slight	1	light	
Aug. 5, 1984	10:30	24	24	offshore	10	none	light	light	moderate	200	light	
Aug. 10, 1984	10:00	18	22	onshore	70	none	light	light	moderate	4	light	
Aug. 13, 1984	11:00	22	22	offshore	10	none	light	light	slight	30	light	
Aug. 18, 1984	12:05	25	22	onshore	0	none	light	light	moderate	125	light	
Aug. 23, 1984	11:00	16	20	offshore	10	none	light	light	moderate	4	light	
Aug. 26, 1984	9:25	22	21	offshore	20	light	light	light	moderate	0	light	
Aug. 30, 1984	12:25	14	19	onshore	70	none	light	heavy	moderate	0	light	
Sept. 3, 1984	-	-	-	-	-	-	-	-	-	-	-	

Table 14a: Fecal coliform and enterococcus characteristics of Grand Beach (West), Lake Winnipeg, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 15, 1984	<100	<100	<100	<100	<100	<100	<100	1	<1	<1	<1	<1	<1	<1
May 31, 1984	<100	<100	<100	<100	<100	<100	<100	8	8	27	2	<1	5	<2
June 3, 1984	<100	<100	<100	100	<100	<100	<100	2	2	<1	3	14	3	<2
June 8, 1984	100	<100	<100	100	100	<100	<100	19	9	2	1	10	5	<3
June 11, 1984	<100	<100	<100	<100	<100	<100	<100	9	5	1	1	2	2	<3
June 16, 1984	<100	<100	-	-	-	<100	<100	<1	2	-	-	-	<1	<3
June 21, 1984	<100	200	100	<100	<100	<115	<103	24	32	25	9	15	19	<5
June 24, 1984	<100	100	<100	<100	100	<100	<102	47	37	51	52	67	50	<7
June 29, 1984	400	400	<100	<100	<100	<174	<110	77	35	18	13	40	30	<8
July 2, 1984	<100	<100	<100	<100	<100	<100	<110	10	14	9	8	8	10	<9
July 7, 1984	<100	<100	<100	<100	<100	<100	<110	5	6	2	10	8	5	<10
July 12, 1984	<100	100	300	<100	100	<125	<113	30	73	58	73	94	61	<14
July 15, 1984	200	1600	600	<100	200	<328	<133	161	149	157	151	148	153	<21
July 20, 1984	<100	200	<100	100	<100	<115	<132	38	56	18	37	49	37	23
July 23, 1984	<100	100	100	400	<100	<132	<135	30	41	113	60	66	56	23
July 28, 1984	<100	<100	<100	100	<100	<100	<135	11	12	8	42	9	13	21
Aug. 2, 1984	<100	100	<100	<100	<100	<100	<126	29	26	25	70	16	29	23
Aug. 5, 1984	<100	100	<100	100	<100	<100	<126	32	9	19	102	19	25	28
Aug. 10, 1984	500	100	<100	100	100	<138	<131	260	208	172	148	>300	>210	>33
Aug. 13, 1984	<100	<100	1300	500	600	<330	<148	5	81	121	100	91	54	>29
Aug. 18, 1984	<100	<100	<100	<100	<100	<100	<127	12	12	8	8	52	14	>26
Aug. 23, 1984	<100	<100	100	100	<100	<100	<125	2	20	32	68	14	16	>22
Aug. 26, 1984	<100	200	<100	<100	100	<115	<123	24	25	7	28	11	17	>21
Aug. 30, 19848	100	100	<100	<100	100	<100	<123	246	212	118	98	68	133	>27
Sept. 3, 1984	<100	<100	<100	<100	<100	<100	<123	24	10	6	12	12	12	>25

Table 14b: Field observations recorded during the microbiological sample collections at Grand Beach (West), Lake Winnipeg, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 15, 1984	12:30	20	11	offshore	10	none	light	none	moderate	0	light	
May 31, 1984	9:20	20	13	-	30	none	light	none	slight	0	light	
June 3, 1984	12:10	22	19	onshore	0	none	none	light	moderate	20	light	
June 8, 1984	12:35	14	16	onshore	100	moderate	light	light	slight	0	light	
June 11, 1984	9:35	16	15	offshore	0	none	none	moderate	moderate	2	light	
June 16, 1984	11:20	21	20	offshore	0	none	none	light	slight	31	clear	
June 21, 1984	10:05	20	21	offshore	90	none	light	light	moderate	6	light	
June 24, 1984	11:40	18	21	onshore	10	none	none	heavy	extensive	32	light	
June 29, 1984	10:00	19	22	offshore	0	none	light	none	moderate	12	light	
July 2, 1984	11:00	22	22	onshore	10	light	light	moderate	slight	1500	light	
July 7, 1984	10:20	19	21	offshore	10	none	none	none	moderate	120	light	
July 12, 1984	11:30	22	23	onshore	40	none	light	light	moderate	900	light	
July 15, 1984	10:05	17	22	onshore	30	light	light	heavy	extensive	30	light	
July 20, 1984	11:20	22	23	onshore	30	none	light	light	moderate	240	light	
July 23, 1984	10:30	20	22	onshore	10	none	light	heavy	extensive	60	light	
July 28, 1984	12:00	24	24	onshore	80	none	light	light	moderate	2000	light	
Aug. 2, 1984	10:35	24	23	offshore	0	none	none	none	slight	60	light	
Aug. 5, 1984	11:00	24	24	offshore	10	none	light	light	moderate	3000	light	
Aug. 10, 1984	10:30	19	23	onshore	50	none	moderate	light	moderate	60	light	
Aug. 13, 1984	11:30	22	22	offshore	10	none	light	light	slight	600	light	
Aug. 18, 1984	11:10	20	23	onshore	0	none	light	light	slight	200	light	
Aug. 23, 1984	11:35	17	20	offshore	10	none	light	light	moderate	60	light	
Aug. 26, 1984	9:50	23	21	offshore	20	light	light	light	moderate	50	light	
Aug. 30, 1984	12:55	14	19	onshore	70	none	light	heavy	moderate	0	light	
Sept. 3, 1984	-	-	-	-	-	-	-	-	-	-	-	

geometric mean objectives for both indicator organisms were not observed. The individual maximum objectives excursions should not have represented an increased health risk to bathers.

Variations in microbiological observations were not correlated ($P\alpha = 0.05$) with observed field conditions.

Noteworthy is the fact that during periods of extremely heavy bather use, concomitant increases in indicator bacterial populations were not observed. This was likely due to the large volume of water available for dilution in cases where such organisms may have been contributed to the bathing area by swimmers.

3.2.7 Patricia Beach, Lake Winnipeg

Fecal coliform and enterococcus population density measurements for Patricia Beach, Lake Winnipeg, are located in Table 15a. Related environmental conditions recorded during bacterial sample collections are located in Table 15b.

While both fecal coliform and enterococcus individual maximum objectives were exceeded on several occasions, excursions of the respective 30-day geometric mean objectives were not observed. Thus, significant impairment of water quality related to recreational use should not have resulted from these individual maximum objective exceedences.

Variations in indicator bacteria population densities were not correlated ($P\alpha = 0.05$) with observed environmental conditions recorded at the times of sample collections.

Table 15a: Fecal coliform and enterococcus characteristics of Patricia Beach, Lake Winnipeg, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 15, 1984	<100	<100	<100	<100	<100	<100	<100	<1	<1	<1	<1	<1	<1	<1
May 31, 1984	<100	<100	<100	100	<100	<100	<100	1	12	<1	3	1	<2	<1
June 3, 1984	<100	<100	<100	100	<100	<100	<100	>300	139	41	>300	>300	>173	>><7
June 8, 1984	<100	<100	<100	100	<100	<100	<100	5	3	8	8	20	7	>><7
June 11, 1984	100	<100	<100	<100	100	<100	<100	6	5	10	15	50	12	>><8
June 16, 1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-
June 21, 1984	<100	<100	<100	<100	<100	<100	<100	30	36	45	52	22	36	>><16
June 24, 1984	<100	<100	<100	100	100	<100	<100	60	63	88	48	50	60	>><20
June 29, 1984	2100	500	1600	200	900	787	<134	118	52	94	47	70	72	>><24
July 2, 1984	100	500	300	<100	100	<172	<145	109	83	116	28	30	62	>39
July 7, 1984	<100	<100	<100	<100	<100	<100	<145	3	8	8	10	8	7	25
July 12, 1984	<100	<100	<100	<100	<100	<100	<145	1	6	1	2	6	2	21
July 15, 1984	<100	300	200	400	200	<217	<162	63	75	66	61	70	67	27
July 20, 1984	<100	<100	<100	<100	<100	<100	<153	30	9	12	17	6	13	25
July 23, 1984	200	300	300	<100	400	<236	<170	50	57	59	50	44	52	26
July 28, 1984	<100	100	<100	<100	<100	<100	<170	8	16	4	9	18	10	20
Aug. 2, 1984	<100	100	<100	<100	<100	<100	<131	14	16	17	15	11	14	17
Aug. 5, 1984	<100	200	<100	<100	200	<132	<127	8	10	3	9	18	8	13
Aug. 10, 1984	300	100	200	100	100	143	<133	>300	>300	206	230	206	>245	>20
Aug. 13, 1984	<100	100	300	<100	600	<179	<143	19	76	94	42	93	56	>30
Aug. 18, 1984	100	<100	100	<100	<100	<100	<130	32	8	36	36	46	27	>27
Aug. 23, 1984	200	100	<100	<100	<100	<115	<132	26	24	30	20	18	23	>29
Aug. 26, 1984	300	100	100	100	<100	<125	<122	17	27	20	18	21	20	>26
Aug. 30, 1984	<100	<100	100	100	100	<100	<122	156	132	148	136	128	140	>36
Sept. 3, 1984	<100	300	100	100	<100	<125	<125	18	40	14	34	30	25	>39

Table 15b: Field observations recorded during the microbiological sample collections at Patricia Beach, Lake Winnipeg, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 15, 1984	15:00	20	10	offshore	0	none	light	light	slight	0	light	
May 31, 1984	8:30	21	16	offshore	30	none	light	none	moderate	0	light	
June 3, 1984	13:15	24	20	onshore	0	none	none	light	moderate	4	light	
June 8, 1984	13:40	14	18	onshore	100	moderate	light	light	slight	0	light	
June 11, 1984	8:30	15	13	onshore	0	none	none	light	moderate	0	light	
June 16, 1984	-	-	-	-	-	-	-	-	-	-	-	
June 21, 1984	8:40	18	19	-	90	none	none	none	extensive	0	light	
June 24, 1984	12:30	19	21	onshore	10	none	light	heavy	extensive	24	light	
June 29, 1984	8:50	18	20	onshore	0	none	none	none	extensive	0	light	
July 2, 1984	12:14	23	23	onshore	10	light	light	moderate	extensive	90	light	
July 7, 1984	9:10	16	19	onshore	20	none	none	none	extensive	3	light	
July 12, 1984	12:20	23	25	onshore	50	none	light	light	moderate	300	light	
July 15, 1984	9:00	17	21	onshore	50	light	light	heavy	extensive	0	light	
July 20, 1984	12:15	23	24	onshore	10	none	light	none	extensive	12	light	
July 23, 1984	9:20	18	21	onshore	10	none	light	heavy	extensive	0	light	
July 28, 1984	12:50	24	25	onshore	80	none	light	none	extensive	800	light	
Aug. 2, 1984	9:30	23	24	offshore	0	none	none	none	moderate	0	light	
Aug. 5, 1984	11:50	25	25	onshore	10	none	light	light	extensive	800	light	
Aug. 10, 1984	9:10	17	21	onshore	80	light	light	light	extensive	0	light	
Aug. 13, 1984	12:20	23	23	offshore	10	none	light	light	slight	300	light	
Aug. 18, 1984	9:45	15	23	onshore	0	none	moderate	light	slight	3	light	
Aug. 23, 1984	12:20	18	20	onshore	10	none	light	moderate	extensive	12	light	
Aug. 26, 1984	8:40	22	21	onshore	20	light	light	light	moderate	0	light	
Aug. 30, 1984	14:00	15	19	onshore	50	none	light	heavy	extensive	0	light	
Sept. 3, 1984	-	-	-	-	-	-	-	-	-	-	-	

Patricia Beach, Lake Winnipeg, was similar in bacteriological quality to other study beaches located on the east side of Lake Winnipeg. Exceedences of the 30-day geometric mean objective for fecal coliform were not observed. Although the enterococcus maximum 30-day geometric mean objective limit was exceeded by one unit on one 30-day period at Victoria Beach (Ski Dock Area), good bacterial quality prevailed. However, individual samples displayed considerably greater variation than was observed for beaches located within the Whiteshell Provincial Park.

3.3 West Side Lake Winnipeg Beaches

3.3.1 Gimli Beach, Lake Winnipeg

Tables 16a and 16b contain fecal coliform and enterococcus characteristics and related field observations, respectively, recorded at Gimli Beach, Lake Winnipeg.

Both fecal coliform and enterococcus densities were somewhat variable, with individual values ranging from <100 to 2200 organisms/100 mL and from <1 to 400 organisms/100 mL, respectively. These values included a number of excursions of the recommended individual maximum objectives. The 30-day geometric mean objective for fecal coliform organism densities, however, was not exceeded during the study period.

Conversely, the 30-day geometric mean density for enterococci organisms exceeded the respective recommended objective for a portion of the study period. The largest recorded exceedence represented an increased risk of 0.12% of contracting gastrointestinal illness while bathing. This is a nominal increase, and should not have seriously

Table 16a: Fecal coliform and enterococcus characteristics of Gimli Beach, Lake Winnipeg, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 16, 1984	<100	<100	<100	<100	<100	<100	<100	2	<1	<1	<1	<1	<1	<1
June 1, 1984	<100	<100	<100	<100	<100	<100	<100	8	<1	5	<1	3	<3	<2
June 4, 1984	<100	<100	100	<100	<100	<100	<100	21	46	58	50	30	38	<5
June 9, 1984	200	<100	<100	<100	300	<143	<109	200	100	400	200	200	200	<12
June 14, 1984	100	100	100	<100	100	<100	<107	64	25	13	19	40	28	<14
June 17, 1984	<100	<100	<100	<100	<100	<100	<107	19	21	18	4	4	10	<22
June 22, 1984	<100	<100	<100	<100	200	<115	<109	43	48	52	48	>300	>69	<27
June 25, 1984	<100	100	<100	-	200	<119	<110	69	63	61	-	57	62	<30
June 30, 1984	<100	<100	<100	300	100	<125	<112	17	18	25	100	74	36	<31
July 5, 1984	400	100	300	500	500	313	<129	>300	>300	>300	>300	>300	>300	>57
July 8, 1984	<100	<100	<100	<100	<100	<100	<129	14	20	4	22	8	11	>48
July 13, 1984	<100	<100	<100	<100	<100	<100	<123	14	32	34	40	26	28	>37
July 16, 1984	100	200	600	200	100	189	<134	95	101	216	258	188	159	>47
July 21, 1984	<100	<100	200	<100	100	<115	<136	33	44	80	114	131	70	>60
July 26, 1984	300	<100	200	100	300	<179	<147	213	83	152	151	>300	>165	>67
July 29, 1984	<100	<100	200	<100	100	<115	<145	80	66	60	148	130	91	>70
Aug. 3, 1984	<100	100	<100	<100	<100	<100	<141	26	32	35	38	41	34	>70
Aug. 6, 1984	400	200	100	1000	500	331	<140	76	72	68	125	81	82	>59
Aug. 11, 1984	<100	<100	100	200	100	<115	<142	65	39	48	49	63	52	>71
Aug. 16, 1984	<100	100	<100	300	100	<125	<146	116	>300	260	86	96	>150	>77
Aug. 19, 1984	<100	<100	100	100	2200	<186	<146	16	19	6	10	16	12	>56
Aug. 24, 1984	100	<100	<100	<100	100	<100	<144	32	>300	28	32	66	>56	>55
Aug. 27, 1984	<100	<100	<100	<100	<100	<100	<134	8	7	6	28	13	10	>39
Sept. 1, 1984	<100	<100	200	100	<100	<115	<134	24	22	36	46	36	32	>34

Table 16b: Field observations recorded during the microbiological sample collections at Gimli Beach, Lake Winnipeg, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 16, 1984	9:30	15	9	onshore	100	none	light	light	moderate	0	light	
June 1, 1984	11:10	20	13	offshore	70	light	light	none	moderate	0	light	
June 4, 1984	10:00	17	14	onshore	10	none	light	light	moderate	0	light	
June 9, 1984	10:40	10	11	onshore	100	moderate	light	heavy	moderate	0	light	
June 14, 1984	9:15	15	16	offshore	75	none	light	light	extensive	0	light	
June 17, 1984	11:15	20	17	offshore	70	moderate	light	none	moderate	8	light	
June 22, 1984	9:30	20	18	offshore	100	heavy	light	none	extensive	0	light	
June 25, 1984	11:40	20	18	onshore	60	none	light	heavy	extensive	2	light	
June 30, 1984	9:00	20	19	onshore	0	none	light	heavy	extensive	0	light	
July 5, 1984	11:00	17	19	onshore	50	none	light	heavy	extensive	0	light	
July 8, 1984	8:50	17	19	onshore	10	light	light	moderate	extensive	2	light	
July 13, 1984	10:55	20	-	onshore	80	light	light	heavy	extensive	0	light	
July 16, 1984	9:20	16	21	onshore	90	moderate	moderate	light	extensive	0	light	
July 21, 1984	10:50	22	21	onshore	70	light	light	moderate	extensive	6	light	
July 26, 1984	9:00	20	22	onshore	20	none	light	light	moderate	6	light	
July 29, 1984	10:50	23	23	onshore	60	none	light	moderate	extensive	40	light	
Aug. 3, 1984	9:10	21	23	offshore	10	none	light	none	moderate	1	light	
Aug. 6, 1984	10:30	24	22	offshore	0	light	light	none	extensive	20	light	
Aug. 11, 1984	9:00	17	21	onshore	10	none	light	heavy	extensive	0	light	
Aug. 16, 1984	11:00	17	21	onshore	70	moderate	none	heavy	extensive	2	light	
Aug. 19, 1984	9:20	19	21	onshore	30	none	light	light	slight	5	light	
Aug. 24, 1984	11:00	19	21	onshore	30	none	light	heavy	extensive	6	light	
Aug. 27, 1984	9:10	20	20	offshore	10	none	light	light	moderate	0	light	
Sept. 2, 1984	-	-	-	-	-	-	-	-	-	-	-	

impaired the recreational quality of Gimli Beach, Lake Winnipeg. The source of the increased densities of indicator organisms was not known.

Variations in microbiological abundancies were not correlated ($P \alpha = 0.05$) with the concomitant field observations.

3.3.2 Sandy Hook Beach, Lake Winnipeg

Tables 17a and 17b contain fecal coliform and enterococcus indicator bacteria group densities measured at Sandy Hook Beach, Lake Winnipeg as well as related field conditions observed at the times of sample collections, respectively.

The individual maximum objective for fecal coliform organisms was exceeded only on one sampling occasion. Exceedences of the respective fecal coliform 30-day geometric mean objective were not observed.

Conversely, numerous individual maximum objective exceedences were observed for the indicator organism group enterococci. The enterococci 30-day geometric mean objective was exceeded for the majority of July and August, 1984. The magnitude of the maximum exceedence related empirically to an approximate predicted increased rate of gastrointestinal illness occurrence of 0.32%. This increase was small in magnitude and should not have significantly impaired the quality of recreational water at Sandy Hook Beach, Lake Winnipeg.

Variations in both fecal coliform and enterococcus densities were not correlated ($P\alpha = 0.05$) with environmental factors recorded at the times of sample collections.

Table 17a: Fecal coliform and enterococcus characteristics of Sandy Hook Beach, Lake Winnipeg, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 16, 1984	<100	<100	<100	<100	<100	<100	<100	<1	<1	<1	<1	<1	<1	<1
June 1, 1984	<100	<100	<100	<100	<100	<100	<100	20	10	9	4	19	11	<3
June 4, 1984	<100	<100	<100	<100	<100	<100	<100	3	1	3	8	6	3	<3
June 9, 1984	100	<100	600	1000	400	<299	<132	500	<100	600	200	300	<283	<10
June 14, 1984	<100	<100	<100	<100	<100	<100	<125	9	6	5	4	7	6	<9
June 17, 1984	<100	<100	<100	<100	<100	<100	<125	20	34	55	40	43	36	<19
June 22, 1984	<100	<100	<100	<100	<100	<100	<120	288	271	>300	175	161	>231	><28
June 25, 1984	200	200	100	<100	<100	<132	<122	67	66	72	50	81	66	><32
June 30, 1984	<100	100	<100	100	<100	<100	<119	74	52	96	35	94	66	><35
July 5, 1984	100	100	<100	100	<100	<100	<119	>300	>300	>300	>300	>300	>300	><53
July 8, 1984	<100	100	<100	<100	100	<100	<119	60	30	48	26	32	37	><72
July 13, 1984	<100	<100	<100	100	100	<100	<104	96	146	128	122	90	115	>64
July 16, 1984	100	<100	100	100	200	<115	<105	184	142	140	146	168	155	>96
July 21, 1984	<100	100	<100	<100	100	<100	<105	>300	>300	>300	>300	>300	>300	>125
July 26, 1984	<100	<100	<100	<100	<100	<100	<105	>300	232	114	197	150	>188	>122
July 29, 1984	<100	<100	<100	<100	<100	<100	<102	>300	>300	>300	>300	>300	>300	>148
Aug. 3, 1984	<100	<100	<100	<100	<100	<100	<102	192	76	64	173	179	124	>160
Aug. 6, 1984	<100	<100	<100	<100	<100	<100	<102	55	22	31	117	97	53	>129
Aug. 11, 1984	<100	<100	<100	<100	<100	<100	<102	52	35	53	41	46	45	>132
Aug. 16, 1984	200	200	100	200	100	151	<107	>300	>300	>300	280	274	>292	>148
Aug. 19, 1984	<100	<100	<100	<100	<100	<100	<105	39	42	25	21	41	32	>122
Aug. 24, 1984	<100	<100	<100	<100	100	<100	<105	80	82	68	>300	76	>100	>106
Aug. 27, 1984	<100	<100	<100	<100	<100	<100	<105	19	15	5	11	7	10	>74
Sept. 1, 1984	<100	<100	<100	<100	<100	<100	<105	37	28	27	24	29	29	>55

Table 17b: Field observations recorded during the microbiological sample collections at Sandy Hook Beach, Lake Winnipeg, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 16, 1984	10:30	15	11	onshore	100	none	light	light	moderate	0	light	
June 1, 1984	10:10	20	16	onshore	30	light	light	light	moderate	0	light	
June 4, 1984	10:50	17	16	onshore	18	none	moderate	light	moderate	0	light	
June 9, 1984	10:05	10	11	onshore	100	moderate	light	heavy	moderate	0	light	
June 14, 1984	9:50	16	16	offshore	75	none	light	light	extensive	0	light	
June 17, 1984	10:10	20	19	offshore	50	moderate	light	none	moderate	0	light	
June 22, 1984	10:00	20	19	offshore	100	heavy	moderate	none	extensive	0	light	
June 25, 1984	11:00	20	19	onshore	60	none	moderate	moderate	extensive	0	light	
June 30, 1984	9:40	21	20	onshore	0	none	moderate	heavy	extensive	0	light	
July 5, 1984	10:25	17	19	onshore	50	none	moderate	heavy	extensive	0	light	
July 8, 1984	9:30	17	19	onshore	10	light	moderate	moderate	extensive	0	light	
July 13, 1984	10:10	18	22	onshore	60	light	moderate	moderate	extensive	0	light	
July 16, 1984	9:50	17	20	onshore	80	moderate	light	light	extensive	0	light	
July 21, 1984	10:25	20	22	offshore	80	light	light	none	extensive	0	light	
July 26, 1984	10:00	22	23	onshore	20	none	light	light	extensive	0	light	
July 29, 1984	10:30	23	23	onshore	60	none	light	moderate	extensive	10	light	
Aug. 3, 1984	9:40	21	23	offshore	10	none	light	none	moderate	0	light	
Aug. 6, 1984	9:45	22	22	offshore	0	light	light	none	extensive	3	light	
Aug. 11, 1984	9:30	17	21	onshore	10	none	light	heavy	extensive	0	light	
Aug. 16, 1984	10:40	17	21	onshore	70	heavy	none	heavy	extensive	0	light	
Aug. 19, 1984	10:05	19	21	onshore	30	none	light	light	moderate	0	light	
Aug. 24, 1984	10:40	19	20	onshore	30	none	light	heavy	extensive	0	light	
Aug. 27, 1984	9:45	21	21	offshore	10	none	moderate	light	extensive	0	light	
Sept. 1, 1984	-	-	-	-	-	-	-	-	-	-	-	

3.3.3 Winnipeg Beach, Lake Winnipeg

Population densities of fecal coliform and enterococcus organisms enumerated at Winnipeg Beach, Lake Winnipeg are located in Table 18a. Relevant field observations are recorded in Table 18b.

The fecal coliform individual maximum objective was exceeded on two sampling occasions (July 13 and August 6, 1984). The respective 30-day geometric mean objective however, was not exceeded during the investigation.

Enterococci population densities displayed considerable variation, with numerous excursions of the individual maximum objective. As well, the 30-day geometric mean objective was exceeded for a large portion of the study period. The magnitude of the exceedences represented an approximate increased risk of 0.16% of contracting gastrointestinal illness while bathing. The small magnitude of this additional risk should not have seriously altered the suitability of Winnipeg Beach, Lake Winnipeg for recreational purposes.

The variability of indicator organism population densities was not correlated ($P\alpha = 0.05$) with observed field conditions recorded during sample collections.

3.3.4 Matlock Beach, Lake Winnipeg

Enumerated indicator bacteria group densities and related field observations at Matlock Beach, Lake Winnipeg are recorded in Tables 19a and 19b, respectively.

Table 18a: Fecal coliform and enterococcus characteristics of Winnipeg Beach, Lake Winnipeg, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 16, 1984	<100	<100	<100	<100	<100	<100	<100	<1	<1	<1	<1	1	<1	<1
June 1, 1984	<100	<100	<100	<100	<100	<100	<100	6	14	9	3	3	6	2
June 4, 1984	<100	<100	<100	<100	<100	<100	<100	33	10	7	17	4	11	4
June 9, 1984	<100	<100	200	<100	100	<115	<104	300	500	300	100	200	246	11
June 14, 1984	<100	100	<100	<100	<100	<100	<102	17	153	20	6	18	22	13
June 17, 1984	100	200	100	100	<100	<115	<106	109	124	87	30	23	61	29
June 22, 1984	<100	100	<100	100	<100	<100	<105	35	215	32	72	94	70	34
June 25, 1984	<100	<100	<100	100	<100	<100	<104	20	24	32	34	31	28	33
June 30, 1984	<100	<100	<100	<100	<100	<100	<104	10	27	22	56	29	25	32
July 5, 1984	300	100	100	300	100	155	<107	164	178	182	256	238	200	49
July 8, 1984	<100	<100	<100	<100	<100	<100	<107	6	8	10	20	12	10	49
July 13, 1984	<100	300	500	600	<100	<246	<117	168	127	156	208	207	170	47
July 16, 1984	100	100	100	200	100	115	<119	126	158	168	84	72	115	57
July 21, 1984	<100	200	200	<100	<100	<132	<121	75	75	96	98	85	85	60
July 26, 1984	200	<100	200	100	100	<132	<125	85	>300	66	194	52	>97	>64
July 29, 1984	<100	100	100	100	100	<100	<125	60	64	36	160	100	74	>72
Aug. 3, 1984	<100	<100	100	200	<100	<115	<127	57	47	49	238	31	63	>81
Aug. 6, 1984	400	100	<100	200	100	<152	<129	102	33	44	74	50	56	>69
Aug. 11, 1984	100	<100	<100	<100	<100	<100	<129	17	35	37	124	96	48	>83
Aug. 16, 1984	200	200	100	<100	100	<132	<120	>300	>300	>300	>300	230	>286	>89
Aug. 19, 1984	<100	<100	100	<100	<100	<100	<118	5	8	2	3	5	4	>59
Aug. 24, 1984	<100	<100	<100	<100	<100	<100	<114	10	12	8	26	44	16	>48
Aug. 27, 1984	<100	<100	100	<100	<100	<100	<110	9	6	9	17	36	12	>36
Sept. 1, 1984	<100	<100	<100	<100	<100	<100	<110	21	21	34	20	32	25	>32

Table 18b: Field observations recorded during the microbiological sample collections at Winnipeg Beach, Lake Winnipeg, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 16, 1984	11:00	15	11	onshore	100	none	light	light	moderate	0	light	
June 1, 1984	9:20	20	16	onshore	30	light	light	light	extensive	0	clear	
June 4, 1984	11:30	17	17	onshore	70	none	light	light	moderate	3	light	
June 9, 1984	9:20	10	14	onshore	100	moderate	light	heavy	moderate	0	light	
June 14, 1984	10:20	17	17	offshore	75	none	light	light	moderate	0	light	
June 17, 1984	9:30	20	19	offshore	30	moderate	light	none	moderate	0	light	
June 22, 1984	10:20	22	20	offshore	100	heavy	light	none	extensive	0	light	
June 25, 1984	10:20	18	20	onshore	50	none	light	moderate	moderate	0	light	
June 30, 1984	10:00	21	21	onshore	0	none	light	heavy	extensive	9	light	
July 5, 1984	9:45	17	19	onshore	50	none	moderate	heavy	extensive	0	light	
July 8, 1984	9:50	20	19	onshore	10	light	light	none	extensive	4	light	
July 13, 1984	9:40	18	22	onshore	60	light	light	moderate	extensive	0	light	
July 16, 1984	10:10	18	20	offshore	80	moderate	light	moderate	extensive	2	light	
July 21, 1984	9:50	20	22	offshore	80	light	light	none	extensive	0	light	
July 26, 1984	10:20	22	22	onshore	20	none	light	light	moderate	12	light	
July 29, 1984	9:50	22	22	onshore	60	none	light	moderate	moderate	30	light	
Aug. 3, 1984	10:00	23	24	onshore	10	none	light	none	moderate	12	light	
Aug. 6, 1984	9:15	22	22	offshore	0	light	light	none	extensive	10	light	
Aug. 11, 1984	9:55	18	21	onshore	10	none	light	heavy	extensive	8	light	
Aug. 16, 1984	10:05	17	21	onshore	80	heavy	none	heavy	extensive	0	light	
Aug. 19, 1984	10:35	19	22	onshore	30	none	light	light	slight	30	light	
Aug. 24, 1984	10:00	19	21	onshore	30	none	light	moderate	extensive	0	light	
Aug. 27, 1984	10:05	21	21	offshore	10	none	light	light	moderate	2	light	
Sept. 1, 1984	-	-	-	-	-	-	-	-	-	-	-	

Table 19a: Fecal coliform and enterococcus characteristics of Matlock Beach, Lake Winnipeg, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 16, 1984	<100	<100	<100	<100	<100	<100	<100	<1	<1	1	4	1	<1	<1
June 1, 1984	<100	<100	1000	500	300	<272	<165	140	137	94	99	105	116	<12
June 4, 1984	200	<100	<100	<100	<100	<115	<146	46	52	49	45	18	40	<18
June 9, 1984	<100	200	600	<100	200	<189	<156	400	700	800	1200	900	753	<46
June 14, 1984	<100	<100	100	100	<100	<100	<143	43	37	53	60	40	46	<46
June 17, 1984	1800	800	800	200	600	673	<209	>300	>300	>300	185	>300	>273	>133
June 22, 1984	<100	<100	<100	<100	200	<115	<189	>300	114	227	68	127	>147	>135
June 25, 1984	<100	100	<100	<100	<100	<100	<173	73	72	76	56	53	65	>122
June 30, 1984	100	<100	<100	<100	<100	<100	<161	68	86	44	59	54	61	>112
July 5, 1984	<100	300	200	<100	400	<189	<154	>300	>300	>300	>300	>300	>300	>126
July 8, 1984	<100	<100	<100	<100	<100	<100	<151	10	44	12	16	18	17	>114
July 13, 1984	100	200	400	300	400	249	<157	>300	>300	>300	>300	>300	>300	>102
July 16, 1984	400	100	200	500	400	276	<178	210	230	306	246	310	257	>126
July 21, 1984	<100	<100	<100	<100	<100	<100	<140	96	112	66	106	67	87	>109
July 26, 1984	<100	<100	100	100	<100	<100	<138	14	27	64	39	127	41	>93
July 29, 1984	<100	<100	<100	<100	<100	<100	<138	82	94	114	58	72	82	>96
Aug. 3, 1984	<100	<100	<100	<100	<100	<100	<138	25	71	113	64	123	69	>98
Aug. 6, 1984	200	300	600	800	400	410	<152	182	91	136	135	166	138	>89
Aug. 11, 1984	100	400	200	100	500	209	<166	39	64	59	61	47	53	>102
Aug. 16, 1984	100	200	100	600	100	164	<158	256	268	>300	>300	>300	>285	>102
Aug. 19, 1984	<100	<100	100	<100	<100	<100	<139	62	23	11	6	1	10	>67
Aug. 24, 1984	100	<100	<100	100	300	<125	<143	74	86	>300	82	162	>121	>70
Aug. 27, 1984	<100	<100	600	<100	700	<211	<157	36	26	78	19	69	39	>70
Sept. 1, 1984	100	<100	200	100	100	<115	<160	60	96	81	75	83	80	>70

Table 19b: Field observations recorded during the microbiological sample collections at Matlock Beach, Lake Winnipeg, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 16, 1984	12:00	15	12	onshore	100	none	light	light	moderate	0	light	
June 1, 1984	8:35	19	19	onshore	10	light	light	light	extensive	0	clear	
June 4, 1984	12:30	17	18	onshore	75	none	light	light	moderate	0	light	
June 9, 1984	8:45	10	14	onshore	100	moderate	light	heavy	moderate	0	light	
June 14, 1984	11:10	18	18	offshore	75	none	light	light	moderate	0	light	
June 17, 1984	9:00	17	22	offshore	30	moderate	light	none	extensive	0	light	
June 22, 1984	11:55	23	22	offshore	100	heavy	moderate	none	extensive	0	light	
June 25, 1984	9:50	17	19	onshore	40	none	moderate	light	extensive	0	light	
June 30, 1984	10:30	22	21	onshore	0	none	light	heavy	extensive	8	light	
July 5, 1984	9:20	16	19	onshore	50	none	moderate	heavy	extensive	0	light	
July 8, 1984	10:25	20	19	offshore	10	light	light	none	extensive	4	light	
July 13, 1984	9:15	18	22	onshore	60	light	light	moderate	extensive	0	light	
July 16, 1984	10:55	18	22	offshore	80	light	light	light	extensive	0	light	
July 21, 1984	9:30	20	22	offshore	80	light	light	none	extensive	0	light	
July 26, 1984	10:50	23	23	onshore	20	none	light	light	extensive	6	light	
July 29, 1984	9:25	21	23	onshore	70	none	light	light	extensive	0	light	
Aug. 3, 1984	10:45	24	24	onshore	10	none	light	none	moderate	10	light	
Aug. 6, 1984	8:55	22	22	offshore	0	light	light	none	extensive	2	light	
Aug. 11, 1984	10:35	19	21	onshore	10	none	light	heavy	extensive	4	light	
Aug. 16, 1984	9:40	16	21	onshore	80	heavy	none	heavy	extensive	0	light	
Aug. 19, 1984	11:20	19	22	offshore	30	none	moderate	light	slight	30	light	
Aug. 24, 1984	9:35	18	20	onshore	30	none	light	light	extensive	0	light	
Aug. 27, 1984	10:40	23	21	onshore	10	none	light	light	moderate	2	light	
Sept. 3, 1984	-	-	-	-	-	-	-	-	-	-	-	

Both fecal coliform and enterococcus densities were observed to be highly variable, with numerous excursions of the respective recommended individual maximum objectives. Additionally, the fecal coliform 30-day geometric mean for the period ending June 17, 1984 exceeded the recommended objective. This exceedence, however, was small in magnitude, and represented an increase of 0.01% in predicted gastrointestinal illness rates.

The enterococci 30-day geometric mean objective was exceeded for the majority of the study period. The enterococci objective excursions represented a maximum predicted increased gastrointestinal illness rate of 0.27%. Since these exceedences corresponded to a small predicted increased gastrointestinal infection rate amongst bathers, the recreational quality of Matlock Beach, Lake Winnipeg should not have been seriously impaired.

The variations in observed indicator bacterial population densities were not correlated ($P\alpha = 0.05$) with recorded associated field environmental conditions.

3.3.5 Sans Souci Beach, Lake Winnipeg

Fecal coliform and enterococcus bacterial population densities measured at Sans Souci Beach, Lake Winnipeg, are located in Table 20a. Associated environmental variables recorded at the times of sample collections are located in Table 20b.

Indicator bacteria population densities measured at Sans Souci Beach, Lake Winnipeg appeared similar to other beaches located on the west side of Lake Winnipeg (Matlock, Winnipeg, Sandy

Table 20a: Fecal coliform and enterococcus characteristics of Sans Souci Beach, Lake Winnipeg, during the bathing season, 1984, with summary calculations.

Date	Fecal Coliform 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean	Enterococcus 1	2	3	4	5	Geo. Mean	30-Day Geo. Mean
May 16, 1984	<100	<100	<100	<100	<100	<100	<100	<1	1	<1	<1	<1	<1	<1
June 1, 1984	<100	<100	<100	<100	<100	<100	<100	90	60	39	58	30	52	7
June 4, 1984	<100	<100	100	<100	<100	<100	<100	4	2	18	17	61	11	8
June 9, 1984	<100	<100	300	100	<100	<125	<106	208	155	500	600	700	368	21
June 14, 1984	<100	<100	<100	<100	<100	<100	<105	3	5	9	3	5	5	16
June 17, 1984	300	<100	<100	200	600	<205	<121	246	150	176	209	174	188	45
June 22, 1984	<100	<100	<100	<100	<100	<100	<117	95	93	73	81	128	92	50
June 25, 1984	<100	<100	<100	<100	<100	<100	<114	102	103	61	60	99	82	54
June 30, 1984	100	<100	<100	<100	<100	<100	<112	50	38	52	52	60	50	54
July 5, 1984	<100	<100	<100	<100	<100	<100	<112	>300	270	282	254	>300	>281	>66
July 8, 1984	<100	100	<100	<100	<100	<100	<112	40	20	16	10	20	19	>71
July 13, 1984	200	<100	200	<100	<100	<132	<113	130	159	168	162	145	152	>64
July 16, 1984	600	300	700	200	100	<302	<130	238	240	204	226	218	225	>103
July 21, 1984	<100	100	<100	<100	100	<100	<119	56	27	14	13	25	23	>80
July 26, 1984	<100	100	<100	<100	<100	<100	<119	9	9	27	83	71	26	>68
July 29, 1984	<100	<100	100	<100	<100	<100	<119	62	132	52	48	54	64	>66
Aug. 3, 1984	<100	<100	<100	<100	<100	<100	<119	18	41	19	27	28	25	>61
Aug. 6, 1984	<100	<100	100	<100	<100	<100	<119	51	50	75	59	59	58	50
Aug. 11, 1984	<100	200	<100	200	<100	<132	<123	56	32	>300	41	39	61	>58
Aug. 16, 1984	200	600	300	100	200	235	<132	256	218	184	148	202	198	>60
Aug. 19, 1984	<100	<100	<100	<100	<100	<100	<115	4	34	10	15	6	10	>41
Aug. 24, 1984	<100	<100	<100	<100	<100	<100	<115	52	204	50	60	44	68	>46
Aug. 27, 1984	100	<100	<100	<100	<100	<100	<115	20	14	5	6	2	7	>39
Sept. 1, 1984	<100	<100	100	<100	<100	<100	<115	27	45	42	30	38	36	>37

Table 20b: Field observations recorded during the microbiological sample collections at Sans Souci Beach, Lake Winnipeg, during the bathing season, 1984.

Date	Time (CDT)	Air Temp. (°C)	Water Temp. (°C)	Wind Direction	Cloud Cover (%)	Recent Precipitation	Visible Algae	Wave Action	Turbidity	Bather Load	Water Colour	Other
May 16, 1984	13:00	20	13	onshore	50	none	light	light	extensive	0	light	
June 1, 1984	8:10	19	16	onshore	10	light	light	light	extensive	0	clear	
June 4, 1984	13:00	17	17	onshore	75	none	light	light	slight	0	light	
June 9, 1984	8:20	10	15	onshore	100	moderate	light	heavy	moderate	0	light	
June 14, 1984	11:40	20	18	offshore	75	none	light	light	moderate	0	light	
June 17, 1984	8:40	16	19	onshore	50	moderate	light	light	moderate	0	light	
June 22, 1984	11:15	24	21	offshore	90	heavy	light	none	moderate	0	light	
June 25, 1984	9:20	16	20	onshore	40	none	light	light	extensive	0	light	
June 30, 1984	10:50	23	24	onshore	0	none	moderate	heavy	extensive	6	light	
July 5, 1984	9:00	16	20	onshore	60	none	loght	heavy	extensive	0	light	
July 8, 1984	10:40	20	20	offshore	10	light	light	none	moderate	8	light	
July 13, 1984	9:00	18	22	onshore	60	light	light	moderate	extensive	0	light	
July 16, 1984	11:15	20	21	offshore	80	light	light	moderate	extensive	28	light	
July 21, 1984	9:10	20	20	offshore	80	light	light	none	extensive	0	light	
July 26, 1984	11:10	23	23	onshore	20	none	light	light	moderate	22	light	
July 29, 1984	9:10	21	21	onshore	70	none	light	light	moderate	0	light	
Aug. 3, 1984	11:10	24	24	onshore	10	none	light	none	moderate	12	light	
Aug. 6, 1984	8:40	22	22	offshore	0	light	light	none	extensive	2	light	
Aug. 11, 1984	10:50	20	20	onshore	10	none	light	heavy	extensive	12	light	
Aug. 16, 1984	9:15	16	21	onshore	80	heavy	none	moderate	extensive	0	light	
Aug. 19, 1984	11:50	19	23	offshore	30	none	light	light	slight	50	light	
Aug. 24, 1984	9:20	17	19	onshore	30	none	light	light	moderate	2	light	
Aug. 27, 1984	11:00	24	20	onshore	10	none	light	light	moderate	0	light	
Sept. 1, 1984	-	-	-	-	-	-	-	-	-	-	-	

Hook and Gimli). Irregular excursions of the fecal coliform individual maximum objectives were recorded. However, the 30-day geometric mean objective for fecal coliform bacteria densities was not exceeded. Both individual maximum and 30-day geometric mean density objectives for enterococcus organisms were routinely exceeded for a large portion of the study period. The exceedences of the 30-day geometric mean objective were estimated to correspond to an increased gastrointestinal illness rate amongst bathers of 0.20%. The small magnitude of this increase should not have significantly impaired the recreational quality of Sans Souci Beach, Lake Winnipeg.

The exceedences were not correlated ($P\alpha = 0.05$) with observed environmental conditions recorded at the times of sampling.

4. CONCLUSIONS

It was concluded that:

1. Study beaches located within the Whiteshell Provincial Park (Falcon (Main), Faloma, Star, West Hawk, Caddy, Betula, Nutimik, and Dorothy) displayed excellent bacteriological characteristics related to recreational water quality.

2. Study beaches located on the east side of Lake Winnipeg (Victoria (Club House Area), Victoria (Ski Dock Area), Hillside, Lester, Grand (East), Grand (West) and Patricia) were of good microbiological quality with regard to recreational water quality objectives. The indicator organisms densities, however, were more variable than densities observed in study beaches located in the Whiteshell Provincial Park.

3. Beaches located on the west side of Lake Winnipeg examined during this investigation (Gimli, Sandy Hook, Winnipeg, Matlock, and Sans Souci) displayed a somewhat reduced microbiological quality. However, the use of two separate indicator organisms for this assessment produced apparently conflicting results. Fecal coliform organism densities were more variable than were observed at other locations examined. However, the 30-day mean density objective was only marginally exceeded on one occasion at one beach. Enterococcus organism densities were also more variable

than at other beaches examined. Numerous exceedences of the enterococcus 30-day geometric mean objective were observed. These exceedences resulted in an estimated maximum increased risk to bathers of contracting gastrointestinal illnesses of 0.32%. The small magnitude of this additional risk should not have significantly impaired the recreational quality of these beaches.

4. Correlations ($P_\alpha = 0.05$) were not observed between fecal coliform or enterococcus densities and environmental conditions, such as bather load and precipitation events, recorded at the times of sample collections at all study beaches.

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